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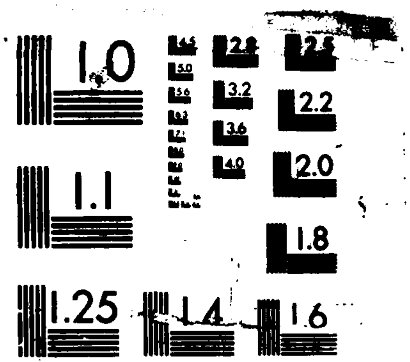

MICROCOPY RESOLUTION TEST CHART

UNITED STATES NAVAL OBSERVATORY

CIRCULAR NO. 172

U. S. Naval Observatory, Washington, D. C. 20392 March 17, 1987

Total Solar Eclipse of 17–18 March 1988

by

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and

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It is a continuing policy of the Nautical Almanac Office to prepare issues of the series of Naval Observatory Circulars containing detailed information for observing most total solar eclipses and some annular solar eclipses. This is a service to the international scientific community, based on agreements with Commissions and Working Groups of the International Astronomical Union.

The target date for distribution is one year in advance of the event. As a regular publication of the Naval Observatory, distribution is made to institutions with which the Observatory has exchange agreements or other obligation. No other mailing list or request file is maintained. Users must make a new written request for each eclipse Circular, no more than 12—14 months in advance. There is no charge for a single copy. Please address requests to:

Eclipse Circulars
U. S. Naval Observatory
Washington, DC 20392-5100

The content and layout of the eclipse Circulars is being reviewed and revised. Users' comments are solicited, on useful features to be continued as well as suggestions for changes or additions.

CONTENTS

GENERAL INFORMATION

A total eclipse of the Sun will occur on Thursday, 17 March and Friday, 18 March 1988. It will be preceded by an associated short partial eclipse of the Moon on 3 March. The duration of totality of the solar eclipse will approach 4 minutes at maximum, the longest since 11 June 1983. Not much of the path is over land.

The last preceding total eclipse of the Sun was on 12 November 1985 in Antarctica. In the meantime, annular—total eclipses of the Sun occurred on 3 October 1986 in the Arctic regions, and 29 March 1987 from Argentina to central Africa. The next total eclipse of the Sun will occur on 22 July 1990 over the arctic regions of Siberia. The next longer total eclipse of the Sun will occur on 11 July 1991 over Hawaii, Mexico, and Central America.

PATH AND VISIBILITY. (Refer to overall line map.) This is another total eclipse of the Sun for which there is little good access to the track on land, and it all lies near the beginning. At approximately 0h 23m U.T. on 18 March 1988, the center of the umbra of the Moon's shadow will first touch the Earth at sunrise in the Indian Ocean, beginning the path of total phase. The path will be approximately 122 km. wide, and duration of totality will be approximately 1m 43s. Proceeding eastward, first "landfall" will occur just after sunrise at the west coast of Sumatra, at 0h 28m U.T. The track will cross Sumatra in three minutes, with the umbral shadow growing so as to increase both the width of the path and the duration of totality. Palembang lies near the central line, and is probably one of the most accessible such places. Bangka Island, just off the east coast of Sumatra, is relatively flat and a mining area. Though the eclipse will occur at a relatively low altitude, the entire width of the path (145 km) is accessible there, and duration of totality at the center will be approximately 2m 30s. The path will reach Borneo at 0h 36m U.T. with the umbral shadow continuing to expand. It will take approximately 13 minutes to cross the island, and the track will lie completely within Indonesian territory on Borneo. It appears unlikely that any portion of the track there is accessible. At the east coast, maximum duration will exceed 3 minutes. The other major land mass in the path of totality is the southern tip of Mindanao. The shadow will arrive there 15 minutes after leaving Borneo. The best observing sites will be there, considering duration of totality (3m 25s), altitude of the eclipse (50°), and accessibility. After crossing Mindanao in 6 minutes, the umbral shadow will sweep on across the Pacific Ocean toward the Aleutian Islands and leave the surface of the Earth at sunset in the Gulf of Alaska, at approximately 3h 32m U.T. on 18 March. Because the track will cross the International Date Line, by local times the eclipse will begin on the morning of Friday 18 March in Indonesia and end on the evening of Thursday, 17 March in the northeastern Pacific Ocean. Maximum duration of totality will be approximately 3m 51s in the Philippine Sea.

Partial phases of the eclipse, of magnitude decreasing with the distance from the path of total phase, will be visible over China and Southeast Asia, eastern Siberia, the northwestern half of Australia, Papua New Guinea, many Pacific Island groups, and western Alaska. (See overall line map elsewhere in this Circular.)

SKY AT MAXIMUM TOTALITY. Diagrams of the sky as it will appear from two major observing regions have been included elsewhere in this Circular. Centered on the zenith for each of two locations, they show planets and stars brighter than magnitude 2.0. At the time of the eclipse, the Sun and Moon will be in Pisces, just south of the Great Square of Pegasus. In the first part of the track, Sumatra, the Milky Way will arch through the zenith from north to south. The Sun and Moon will be relatively low in the east. Mars (magnitude 0.8) and Saturn (0.5) will be a prominent red and yellow pair in Sagittarius to the southwest. Mercury (0.0) will be 25 degrees higher than the Sun, to the southeast; continuing from there at a lower altitude around to the south will be a string of bright stars nearly around the horizon. The summer triangle of the Northern hemisphere will ride high to the north. By the time the umbra reaches Mindanao, all of the above will appear to be shifted to the west, so that the Sun will be halfway to the zenith, but still nearly due east. Mars and Saturn will be at about the same altitude as the Sun, but to the southwest. Mercury will be just southeast of the zenith, opposite the summer triangle on the northeast. The main difference will be that brilliant Jupiter (−2.1) and Venus (−4.3) will have risen just north of east, so that five visible planets will be up.

PARAMETERS. The predictions in this Circular are derived from the solar and lunar data contained in an ephemeris developed jointly by the Jet Propulsion Laboratory and the U. S. Naval Observatory for use in the *Astronomical Almanac for 1984* and after. In order to best take into account the rough limb of the Moon, the value of k = 0.2725076 for the ratio of the radius of the lunar profile to the Earth's radius is used throughout the calculations. The IAU adopted the new value for k in August 1982. Along with that value, corrections have been applied to both lunar latitude and longitude to help account for the difference between center of figure and center of motion. (See Elements of the Eclipse.) It is expected that the observer will then make final limb corrections as described elsewhere in this Circular. As usual, all time arguments are in Universal Time (U.T.), using the best correction available at the time of preparation. Also, the convention of longitude positive east is used.

DEFINITIONS OF TERMS.

First and *fourth contacts* are, respectively, the beginning and the end of the partial phase. *Second* and *third contacts* are, respectively, the beginning and the end of the total phase, if it occurs at the location given. *Duration* is the time interval between second and third contacts. Dot leaders indicate that a phenomenon occurs below the horizon for the given location.

The *position angle* of a point of contact on the solar limb is measured eastward (counterclockwise) around the solar limb. P is the position angle measured from the north point of the limb; V is the position angle measured from the vertex point. The north point lies on the great circle arc drawn from the north celestial pole to the center of the solar disk; the vertex lies on the great circle arc drawn from the zenith to the center of the solar disk. If the angle is listed as negative, you may add 360 degrees.

The *azimuth* of the Sun is measured along the horizon clockwise from the north point eastward to the foot of the great circle arc drawn from the zenith through the center of the solar disk down to the horizon. If it is listed as negative, either add 360 or measure westward from north.

The *magnitude* of the eclipse is the fraction of the apparent diameter of the solar disk covered by the Moon at the time of greatest phase, expressed in units of the solar diameter.

Degree of *obscuration*, prepared especially for this Circular, is the fraction (per cent) of the area of the apparent solar disk obscured by the Moon at maximum eclipse.

Inexperienced observers are cautioned to observe only by use of projected images, and not to use any method which would cause them to look directly toward the Sun.

LOCAL CIRCUMSTANCES. A table of accurate local circumstances for a list of geographic locations is provided. They were selected for location near the path, general geographic distribution, and size of population. Coordinates were taken from *The Times Atlas* or read from the detail maps in this Circular. All coordinates are approximate and assumed to be sea level. The printed circumstances correspond to the printed coordinates, in case there should be an error in identification or coordinates. It is often difficult in preparing maps and local circumstances to ascertain the correct name and spelling for a given location. Therefore, the information presented here is for location purposes only, is not authoritative, and does not imply official recognition of the status of any area by the United States government.

For the user who wishes to calculate his own local circumstances, the elements of conjunction, general circumstances, and Besselian Elements for Universal Time arguments are presented. The Besselian Elements are given as usual in tabular form, and also in polynomial form, courtesy of Dr. L. E. Doggett. Precepts for the calculations of local circumstances may be found in the Explanation of *The American Ephemeris and Nautical Almanac for 1980* or earlier years.

ESTIMATING LOCAL CIRCUMSTANCES

CONTACT TIMES. Beginning and end of the partial phase, or first and last contacts, can be estimated using the one-page overall map reproduced from the *Astronomical Almanac*. The dashed lines show the surface outline of the Moon's penumbra at a time interval of 30 minutes. The short dashes show the leading edge, the long dashes show the trailing edge. First contact occurs when the leading edge passes over the location in question, last contact occurs when the trailing edge passes. Duration is the time difference between contacts. The time halfway between is the middle of the eclipse. This is near the time of maximum eclipse, but not necessarily identical. At a given location, one need only estimate the intermediate position of the penumbra's edge between the starting and ending lines on either side and thus the time of the contact. For observers within the elongated teardrop curves to the extreme east and west, part of the eclipse occurs below the horizon.

Low precision times of second and third contacts in the central path can also be estimated. The central path over land is shown on a series of detail maps in the last part of this Circular. A few pages before the maps is a table of Local Circumstances for Points on the Central Line. On the maps, the heavy solid lines mark the northern and southern limits of the predicted path. Each dashed line represents the projection of the diameter of the umbra, joining the northern and southern limits and central point for the indicated instant—at which all points on the dashed line observe maximum eclipse.

Use the maps and the table as follows: Find on the maps the location in the path for which you want local circumstances. From the one-minute cross lines on either side, estimate or measure the time t_0 when the projected axis line of the umbra will pass over the point. Turn to the Table of Local Circumstances for Points on the Central Line. Find where the time t_0 fits into the first column on each page. Using the appropriate fraction of the time interval, read across both pages and interpolate the times of second and third contacts, the duration (D), and width of path. Make a note of the angles P and V for each contact, and also the altitude (a) and azimuth (A) of the Sun at maximum eclipse. Turn back to the map. If you mark the cross lines for the second and third contact times, you can see the breadth of the projected shadow. Now draw a line through the observing point perpendicular to the path. Estimate or measure how far the point is from the center of the path and call this quantity a. Set b equal to half the width of the path. Next compute the approximate duration (T) for the selected location by $T = D\sqrt{(1-(b/a)^2)}$. Then the time of second contact is approximately $t_0 - T/2$, third contact $t_0 + T/2$.

POSITION ANGLES. The lunar limb profile for this eclipse is provided elsewhere in this Circular. For locations in the central path, the predicted times and position angles of contacts are based on the Moon's mean limb (the dashed circle). Correction for limb irregularities is discussed later. In working with this construction, remember that position angles are given for the solar disk, which is observable, but corrections are based on features on the lunar disk, shown in the diagram. The two nearly coincide between second and third contacts, so it is adequate to plot angles pertaining to the Sun on the lunar diagram. However, this is not the case for first and fourth contacts. You may find it convenient to use a transparent overlay with a circle of radius three inches.

For each second or third contact to be sketched, take from the tables the time of contact (t_c), the angles P and V, and the altitude (a) and azimuth (A) of the Sun at maximum eclipse, as described above. Convert the time of contact to hours and decimals. The position angle of the lunar axis (C) is a function of time, the position of the Moon and the Sun, and the location of the observer, but for this eclipse it may be taken as a constant C = 338 to the nearest degree.

On the diagram, N marks lunar north. Using the four direction tick marks, find the center of the circle. Draw a line from the center through N. Next measure the angle C westward (clockwise) from N. Mark the point on the mean limb and draw a line from the center through it. This points to the Earth's north celestial pole. From this line, measure back the angle P eastward (counterclockwise) to find the point of contact on the mean limb. Draw a line from the center out through that point. Finally, from that line, measure through the angle V westward (clockwise). Draw a line from the center through this point. This line points to the observer's zenith. Now you can visualize events as follows: Face in the direction of the Sun's azimuth (A), measured in degrees positively from the north point of the horizon around clockwise to the east, hold the diagram up at arm's length at the altitude (a) of the Sun at maximum eclipse, and turn it so that the line pointing to the zenith points straight up. The line to the north point of the disk will point to celestial north for the observing site, and the point of contact at the limb will be at its correct apparent orientation.

To get position angles for locations not listed in the tables, follow the directions above and plot the points of second and third contacts for the interpolated location *on the center line*. Draw a line connecting the two contacts on the mean limb. It should pass through the center of the disk. Next, draw or construct a perpendicular diameter, which runs approximately north/south. Taking (b/a) from the calculation of duration, measure off (b/a) $\times$ radius from the center of the circle along the north/south diameter in the opposite direction as the observing site. Mark the point on the diameter, and draw or construct a perpendicular line parallel to the one through the central line contact points. This new line will intersect the mean limb at approximately the points of contact. The eastern point is for second contact, the western is for third contact. This construction is not as accurate as a full calculation, but adequate for field estimates.

ACKNOWLEDGEMENTS. Marie Lukac prepared the overall line map. William Harris prepared the detail maps of the path over land. The latter is presented on portions of Operational Navigation Charts (ONC) K-11, L-11, L-12, M-10, M-11, scale 1:1,000,000, Lambert Conformal Conic Projection. These maps are a product of Defense Mapping Agency Aerospace Center. The portions in this Circular are reduced to 60% of original size, enlarging the scale from 15.78 miles/inch to 26.3 miles/inch. Map sheets may be purchased by ordering from this address:

NOAA Distribution Branch N/CG33
National Ocean Service
Riverdale MD 20737

The Lunar Limb Profile chart was prepared using software subroutines from the occultation program of the Nautical Almanac Office.

The polynomial representation of the Besselian Elements was programmed by Dr. Leroy Doggett, Nautical Almanac Office.

Climatological data was contributed by a meteorologist, Jay Anderson, of Vancouver, B.C.

The sky diagrams were prepared using programs provided by Mr. Timothy Carroll and Mr. James DeYoung, Nautical Almanac Office.

The charts to correct contact times for the effects of lunar limb features were provided by Mr. David Herald, Canberra, A.C.T.

OBSERVATIONS. Precise observations of the second and third contact times, at any part of the path, but especially the northern and southern limits, are needed and requested. Since precise coordinates of the observer must be determined, reports of such timings should include location information such as nearest settlement, roads to the site, distance to nearby buildings and the nearest road intersection, distance from the center of the road, etc. The method of timing should also be described. Please send reports to

Nautical Almanac Office
U. S. Naval Observatory
Washington, D.C. 20392-5100, U. S. A.

Information on photography, direct viewing, and projection methods may be found in the following publications:

"Safe Solar Filters," by B. Ralph Chou, *Sky and Telescope*, August 1981, p. 119.
"Observing the Sun in Safety," by J. C. D. Marsh, *J. Brit. astron. Assoc.*, 1982, 92, 6, p. 237.
Astrophotography Basics, Kodak Customer Service Pamphlet AC—48, 1981.
A Complete Manual of Amateur Astronomy, by P. Clay Sherrod, Prentice Hall, 1981.
Eclipse, by Bryan Brewer, 1979.
Observe: Eclipses, by R. Sweetsir and M. Reynolds, Astronomical League, 1979.

FURTHER INFORMATION. Inquiries concerning special calculation of local circumstances and extensions or modifications of data in this publication should be directed to the Nautical Almanac Office.

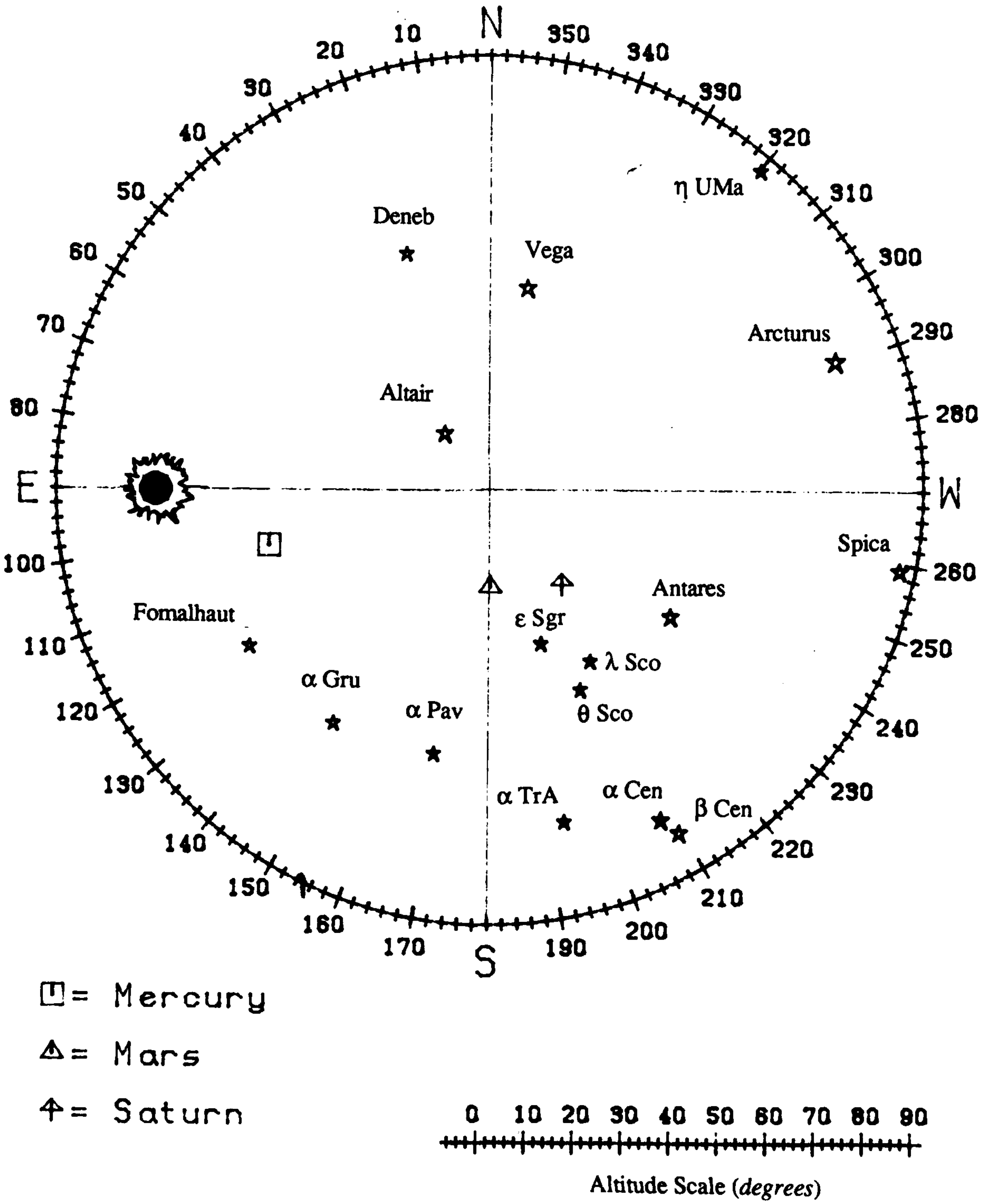
Just as this Circular was going to press, the following message was received:

"Just recently, the Philippine Astronomical Society together with the Ministry of Science, the Philippine Atmospheric Geophysical and Astronomical Services Administration, the Manila Observatory, the National Institute of Physics and the National Research Council of the Philippines with the support of some other agencies like the Ministry of Tourism and the Ministry of National Defense organized a National Solar Eclipse Committee in preparation for the March 18, 1988 total Solar Eclipse over Mindanao, Philippines."

Philippine Astronomical Society, Inc.
1947 Gonzales Street
Pandacan, Manila
Philippines
Tel. No. 58—64—91

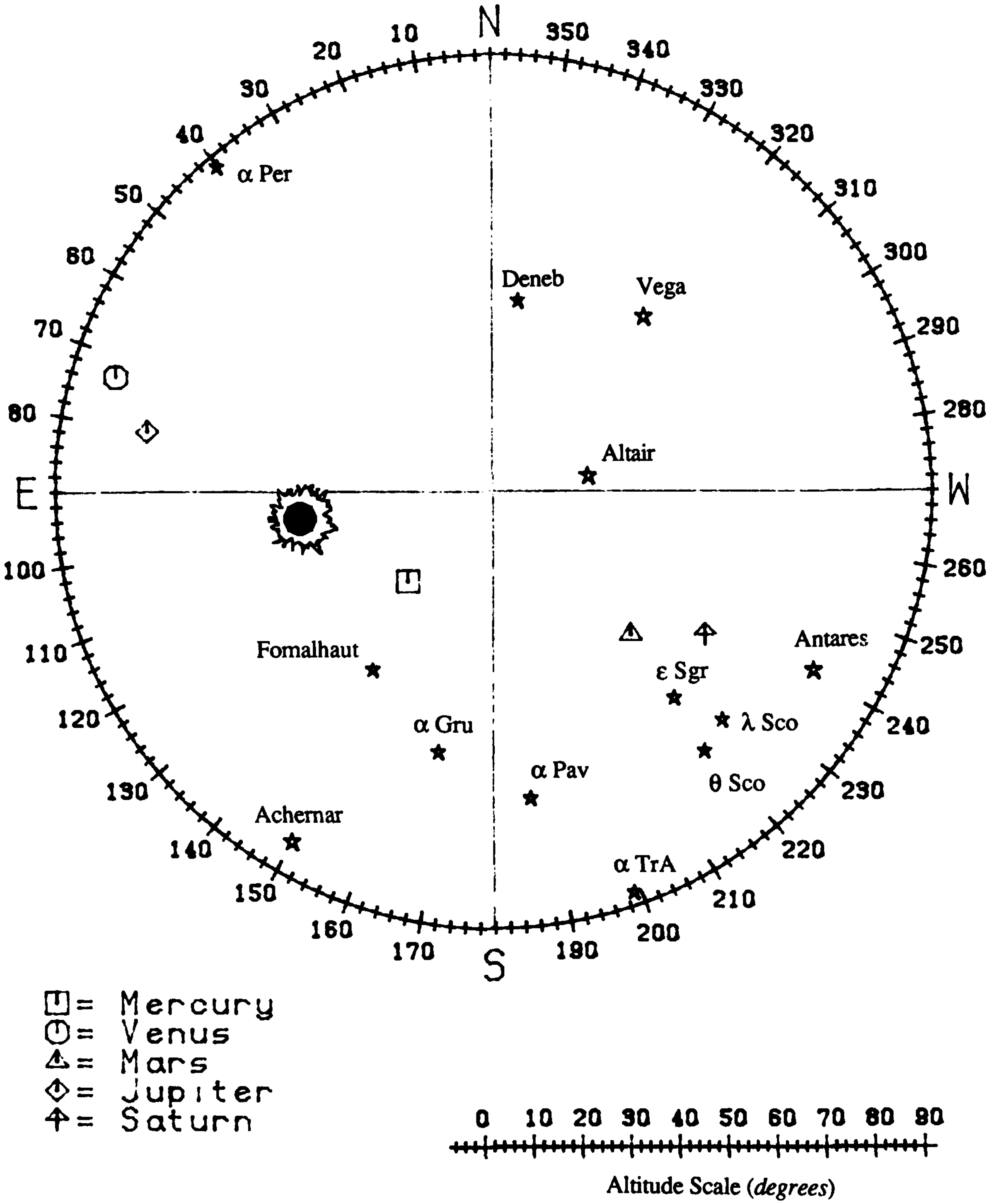
Sky Diagram for **Palembang, Sumatra; Indonesia**
18 March 1988 0^h 31^m U.T.

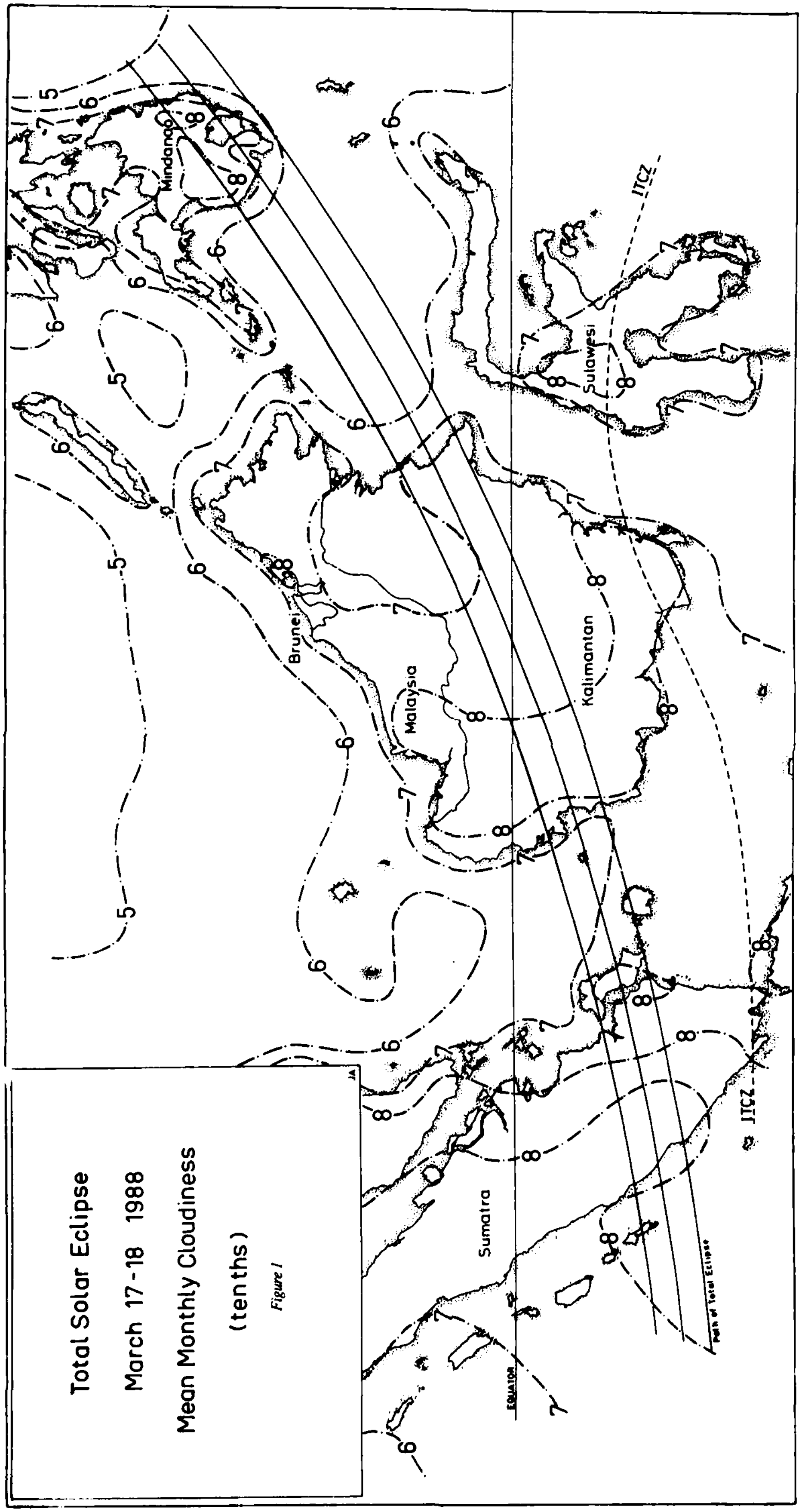
Diagram centered on zenith



Sky Diagram for **Buayan (General Santos), Mindanao; Philippines**
18 March 1988 $1^h\ 05^m$ U.T.

Diagram centered on zenith





Total Solar Eclipse
March 17-18 1988
Mean Monthly Cloudiness
(tenths)
Figure 1

ECLIPSE WEATHER: PROSPECTS FOR MARCH 1988

by Jay Anderson
Pacific Weather Centre
700—1200 W. 73rd Ave., Vancouver, B.C., Canada, V6P 6H9

On the twentieth of June an eclipse of the sun began at eleven o'clock, and at thirteen minutes after twelve it was so far eclipsed, that it could not be seen at all. It seemed as if it were night and the stars were seen in the sky, so that we were forced to light candles in order to eat; for there was a dinner that afternoon, on the occasion of a certain feast. As far as I know, this eclipse was not seen in Nueva Espana: it is the most complete one that I have ever seen, though I have seen many.

—Papeles de los Jesuitas, 1628—1629

The unknown Jesuit who penned that description from Manila was blessed with clear skies and an excellent view on that lucky June day in 1629, though appetite seems to have overcome curiosity for some members of the order. As the moon's shadow returns to Southeast Asia for the third time in five years, weather prospects for 1988 appear equally promising at many locations.

BROAD SCALE WEATHER PATTERNS ALONG THE ECLIPSE TRACK

In March, the mean position of the earth's weather 'equator', the Intertropical Convergence Zone (ITCZ), lies to the south of the eclipse track, across southern Sumatra and southern Borneo (Figure 1). The ITCZ marks the point at which air masses from the northern and southern hemispheres collide, giving rise to the deep convective clouds and heavy showers which are typically associated with tropical weather.

The ITCZ reaches its most southerly position in January or February and by March is beginning to move northward with the sun. The zone is very disorganized, with considerable day-to-day oscillation in its position and variation in its associated weather conditions.

North of the ITCZ, the Northeast Monsoon winds take hold, carrying dry Asiatic air (which has been considerably moistened by its passage over water) into the Philippines. These winds bring the dry season to much of Mindanao, particularly where mountains block the steady flow of the wind.

Still farther north along the eclipse track, where equatorial climates give way to more temperate weather, the Northeast Monsoon winds are replaced by the North Pacific Trades. At eclipse time the trades are likely to be found over the northern Philippines, and along the ocean track to about 20 degrees north latitude.

Between 20 and 40 degrees north, the moon's shadow crosses the Subtropical High, with its light winds and sunny skies, and then moves into the regime of the temperate zone westerlies which affect much of the North American continent. Migrating Pacific lows embedded in these westerlies bring frequent storms and cold blustery weather, making the area south of the Aleutian Islands the cloudiest along the shadow's path.

THE WEATHER IN DETAIL

CLOUDINESS

The early portion of the eclipse track, over Sumatra and southern Borneo, lies close to the mean position of the ITCZ and tends to be cloudier than other over-land parts of the track (Figure 1). In general, daytime cloud cover varies between 70% and 90% over Sumatra and Kalimantan, with considerable variation due to terrain and water influences. Because one particular statistic does not necessarily give a reliable comparison of the prospects from one point to another (due in part to variations in observing routines from place to place), Table 1 lists four measures of cloudiness for stations along the path of the eclipse. Column 6 is mapped in Figure 1; columns 7, 8, and 9 offer additional information which may make the choice of an observing site more definite.

One location along the path of totality stands out as the most likely to experience sunny skies. This is at General Santos (Buayan), where the moon's shadow first crosses onto the Philippine island of Mindanao. At this point the track is well away from the mean position of the ITCZ, and is affected by the dry Northeast Monsoon winds. General Santos (Buayan) is one of the driest locations in the Philippines, and in March it is at the height of its dry season.

A good part of the dry and sunny weather at this location is due to the terrain. General Santos is surrounded by mountains on the east, north, and west sides, and the sea on the south. The mountains wring the moisture from the prevailing northerly monsoon, and the downslope flow on their lee side adds to the drying of the airmass. General Santos (Buayan) is exposed to southerly winds for only 4% of the hours during March.

Statistics for Tarakan, on the east coast of Borneo, suggest that that coast may also be a good site for viewing the eclipse, though access could be a problem.

In general, clouds tend to be less over water than over land, since it is daytime heating of the ground which leads to the development of the cumulus cloud which is so common in this area. For those who wish to observe from ships, the portion of the eclipse track over the Celebes Sea or to the east of the Philippines seems most promising (Figure 2).

TROPICAL CYCLONES

Tropical cyclones (known as typhoons if severe enough) are common in the waters surrounding the Philippines, with a mean annual frequency of about 20. Fortunately, March is the month in which tropical storms are least likely to occur, and Mindanao is well away from the usual track. The probability that one would interfere with observations on land is very low, though over-water observers east of the Philippines would have to keep a casual lookout for them.

TEMPERATURE

Mean daytime highs over Indonesia and the Philippines are generally in the low 30's Celsius (about 88°F). Cooler temperatures will be found at higher altitudes, falling at a rate of about 0.6° C per hundred metres of ascent. Nighttime temperatures are also very similar along the land portion of the eclipse track, with morning lows ranging through the low 20's (about 72° F) at sea level sites.

Further north, temperatures range gradually downward, reaching to the freezing point off Alaska.

HUMIDITY

The discomfort associated with high humidities is likely to be the most telling aspect of tropical weather for those not acclimatized to it. Columns 4 and 5 in Table 1 list the relative humidity in the morning and again in the early afternoon for most sites. A value of 70% with a temperature of 30° C would be very humid by northern hemisphere standards, comparable to the muggy airmasses from the Gulf of Mexico which often cover the southeastern USA in summer months. As with temperature, drier air is found at higher altitudes, especially in the Philippines.

VISIBILITY

Visibilities are usually good over equatorial portions of the eclipse track, though morning fog is not uncommon in interior valleys where colder air pools overnight; it usually dissipates by 9 a.m. (after the eclipse!). Fog can also occur when stratiform cloud piles up against rising terrain, and eclipse observers will have to select higher sites with care to avoid upslope winds. Haze can be a problem over Borneo, if the season is very dry, but otherwise should not hinder eclipse observations.

The frequency of foggy conditions increases as the eclipse track passes the latitude of Japan, reaching a 15% frequency of less than 2 miles visibility south of the Aleutians.

WINDS

Winds blow almost monotonously from northerly directions across the Philippines, but tend to become more westerly in regions close to the ITCZ. Islands and mountains will deflect the winds so that they blow parallel to the coast or mountain axis. Wind speeds tend to be light, except in storms. Land and sea breezes are very common near the coast, but should not be well established at the morning eclipse time.

North of the trade wind belt, winds become more variable and increase in strength. At temperate latitudes, winds will depend on the pressure pattern on eclipse day, though northerlies are slightly more frequent than other directions at Alaskan stations.

SELECTING THE ECLIPSE SITE

From a meteorological view, a tropical eclipse is a nighttime event, in that the clouds which form and dissipate follow a pattern which is driven by falling surface temperatures. The changes which occur as the eclipse progresses may be extremely rapid, and it is unlikely that the conditions which prevail at the start of the eclipse will be those which dominate at the end, unless it is clear.

The most common type of cloud across the tropical portion of the eclipse is cumuliform, which builds rapidly as the ground is heated during the morning. This type of cloud will tend to dissipate at some point between first and second contact. Stratiform cloud may form as the cumulus dissipates, though in general the eclipse cooling would appear to be of too short a duration to allow an extensive cloud cover to grow. The exception is where the winds are blowing upslope, for then the additional influence of cooling by lifting of the airmass comes into play, and certain hilly locations may suddenly deteriorate just before totality.

To assess the importance of the various influences, it is advisable to monitor the weather conditions in the mornings and evenings prior to eclipse day. Night is, after all, a form of solar eclipse, and the behavior of the clouds as temperatures fall may provide valuable clues for site selection.

If cumulus clouds dissipate early, likely before the sun has even set, then the prospects for eclipse day are favourable, providing no change in the overall condition occurs. Keep watch over nearby hills before the light disappears, to see where stratiform cloud forms most quickly, and then avoid those locations on eclipse day. If darkness comes too quickly, it may be necessary to visit the site and observe the cloud conditions, (or even hold a star party).

Morning conditions (at sunrise) will also give an indication of cloud prone areas, though the 12 hours of cooling overnight will build more extensive cloud cover than the one or two hours of cooling associated with an eclipse. Nevertheless, early risers may obtain valuable clues on which areas to avoid. Both Tarakan and General Santos (Buayan) have a history of clearing skies overnight.

Observations should be made of the low clouds, since middle and high clouds are much less influenced by the eclipse cooling. The presence of considerable high level cloudiness at eclipse time would be cause for some concern. Being able to recognize the general types of cloud will aid in assessment of the viewing site and topographic maps could be useful.

Watch the direction that the clouds move to ascertain the direction of the winds above the surface. Since winds are relatively light, it may take some time to see the motion (a telescope will help here). Once cloud directions have been determined, position yourself so that winds are blowing downhill toward you for the eclipse. It is usual for winds below 5,000 feet to blow from the east or northeast over Mindanao, so that westward facing slopes would be most favored.

SUMMARY

The equatorial regions of the earth have a deserved reputation for sunny skies, and with careful planning, it is likely that the eclipse can be successfully viewed from many locations. Philippine sites have a history of sunnier weather than those in Indonesia, but local terrain may have the most important influence on the clouds. The favourable skies which graced the Jesuits 357 years ago are likely to awe modern viewers again in 1988.

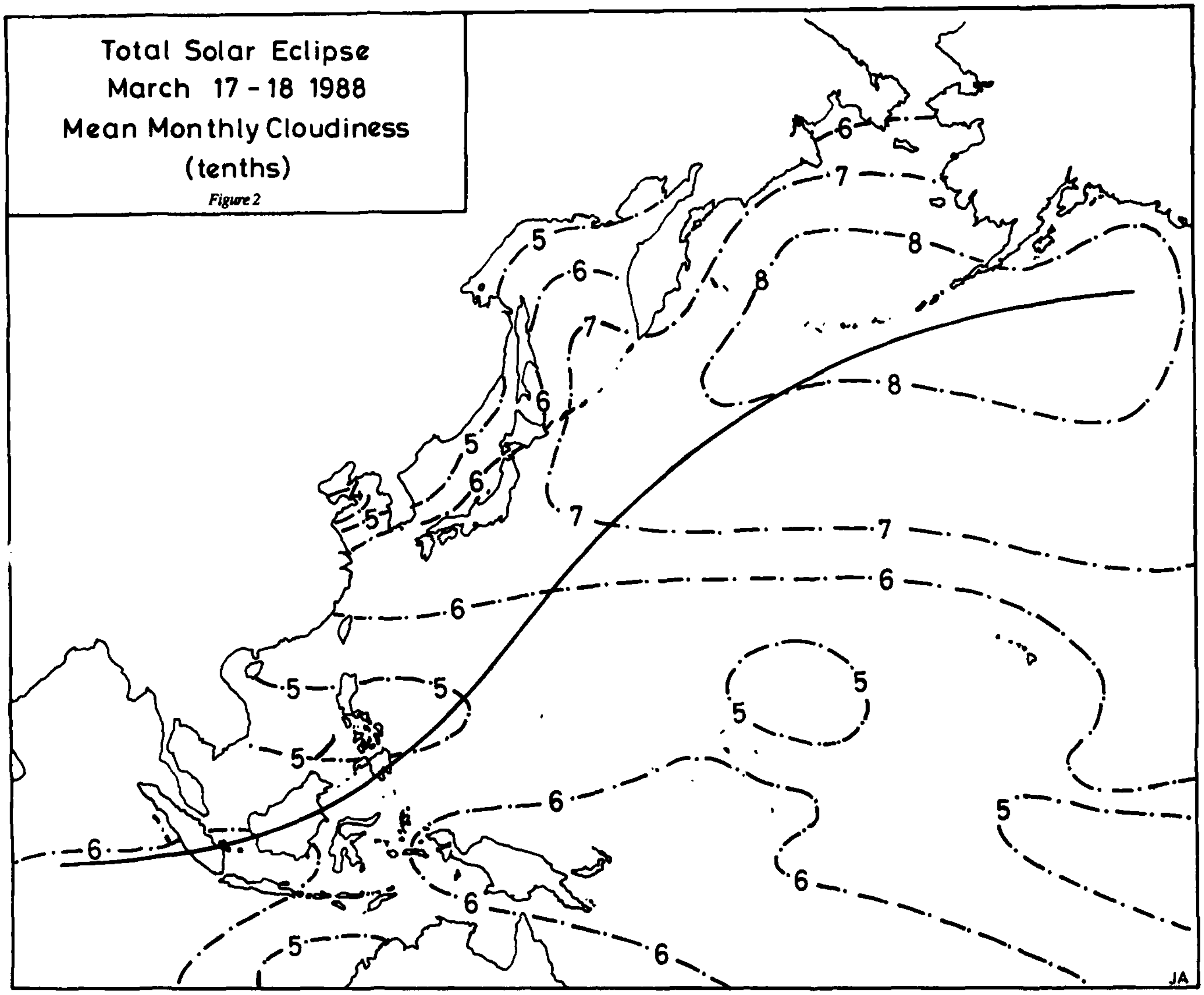
Table 1: Climatological parameters along the eclipse track.

Station	Parameter 1	2	3	4	5	6	7	8	9	10
Indonesia (Sumatra)										
Pekanbaru	15	32	22	97	63	78	4.2	0.9	1.9	NE
Tabing/Padang	15	30	23	94	71	76	4.4	2.3	0.0	W
Rengat	13	31	23	98	67	88	2.6	-	-	N
Jambi	17	31	23	97	67	85	3.8	3.3	-	N
Bengkulu	-	32	22	96	66	74	4.4	0.7	-	W *
Palembang	17	32	23	96	67	74	4.2	0.5	0.7	N *
Astraksetra	-	31	23	98	69	79	3.7	-	-	N
Tanjungpinang	11	31	22	94	65	71	4.4	-	-	N
Dabo/Singkep	-	-	23	90	66	77	5.1	8.0	11.7	NE
Pangkalpinang	16	31	24	95	71	82	3.5	2.2	1.3	N *
Tandjungpandan	-	29	23	83(1)	-	-	-	2.6	4.3	- *
Indonesia (Java)										
Serang	14	31	23	95	73	83	4.2	-	-	W
Jakarta	16	31	24	93	67	81	4.1	-	-	W
Bawean/ Sangkapura	16	30	24	89	79	84	3.8	-	-	W
Indonesia (Kalimantan)										
Singkawang	-	31	22	97	70	76	4.2	-	-	N
Pontianak	14	32	23	98	67	77	4.4	1.1	2.3	N
Banjarmasin	20	31	23	97	71	87	3.4	3.2	2.3	N
Balikpapan	17	31	24	93	75	76	4.4	3.5	6.6	N
Tarakan	19	31	24	95	73	70	-	3.7	19.8	N
Indonesia (Sulawesi)										
Gorontalo	-	32	23	96	66	65	4.3	-	-	N
Manado	17	30	22	93	75	71	4.4	5.6	5.5	N
Singapore										
Singapore	11	31	23	95	68	83	6.3	-	-	NE
Malaysia (Sarawak)										
Kuching	18	31	23	94	69	84	4.4	-	-	NE
Sibu	18	32	22	98	68	83	5.0	-	-	NE
Bintulu	14	30	23	95	75	78	5.7	-	-	SE/NW
Malaysia (Sabah)										
Keningan	9	-	-	-	-	74	-	-	-	-
Tawau	-	32	22	-	-	-	-	-	-	-

	1	2	3	4	5	6	7	8	9	10
Philippines (Mindanao)										
Jolo	6	31	22	89	75	70	-	2.2	2.9	NE
Zamboanga	4	32	22	77	65	73	6.8	8.2	12.2	W
Kabacan/Cotabato	7	34	22	77(1)	-	81	6.6	8.0	1.1	-
General Santos/ Dadiangas	5	34	22	73	58	69	-	16.4	25.9	- *
Malaybalay	8	29	18	82	57	73	8.1	11.1	11.7	-
Davao City	7	32	22	81	63	79	-	8.8	4.8	N *
Francisco Bangoy	-	32	22	78(1)	-	-	-	7.8	4.8	- *
Hinatuan	20	30	22	90	78	78	-	1.4	5.0	N
Caroline Islands										
Ulithi	-	30	26	81(1)	-	-	-	-	-	-
Guam										
Anderson AFB	-	27	24	81(1)	-	-	-	0.7	2.4	-
Agana NAS	-	29	24	77(1)	-	-	-	0.6	2.4	-
Japan (Volcano and Bonin Islands)										
Iwo Jima	-	28	18	77(1)	-	-	-	6.0	8.6	-
Chichijima	11	21	16	77	64	65	5.6	3.3	-	N
Japan (Marcus Island)										
Minimitorishima	8	25	19	73(1)	-	52	7.5	6.8	-	NE
U.S.A. (Alaska)										
Kodiak	15	2	-3	76	69	70	-	5.5	7.2	NW
Adak Naval Stn.	-	3	-1	84(1)	-	83(2)	-	0.2	3.2	W
Cold Bay	17	1	-5	85	79	-	-	2.5	4.7	NNW

Legend:

1: Mean number of days with measurable precipitation in March.
2: Mean daily high temperature for March in degrees Celsius.
3: Mean daily low temperature for March in degrees Celsius.
4. Mean relative humidity at 7-8 am local time for March (%). (1) indicates that mean daily RH was substituted.
5. Mean relative humidity at 1-2 pm for March (%).
6. Mean daytime cloudiness for March in percent. (2) indicates that mean daily cloudiness was substituted.
7. Mean daily sunshine (hours/day) for March.
8. Mean number of days in month with less than 3/10ths cloud cover and visibility greater than 3 miles (ie: sunny with no fog) at or near eclipse time (morning hours).
9. Same as 8, but for evening or overnight hours.
10. Most common wind direction for month at eclipse time.
* Indicates station is in zone of totality.


Total Solar Eclipse
March 17 - 18 1988
Mean Monthly Cloudiness
(tenths)
Figure 2
5
6
7
8
JA

PATH OF THE TOTAL PHASE

U. T.	Northern Limit Longitude	Northern Limit Latitude	Central Line Longitude	Central Line Latitude	Southern Limit Longitude	Southern Limit Latitude
h m	° '	° '	° '	° '	° '	° '
Limit	+ 86 00.0	− 3 50.5	+ 86 05.4	− 4 21.9	+ 86 10.6	− 4 53.2
0 25	+ 93 27.0	− 3 38.9	+ 95 00.1	− 4 06.9	+ 96 21.9	− 4 35.2
0 30	+102 57.4	− 2 26.7	+103 50.3	− 2 55.5	+104 41.3	− 3 24.7
0 35	+108 14.5	− 1 11.0	+109 00.1	− 1 40.4	+109 44.8	− 2 10.1
0 40	+112 10.0	+ 0 05.8	+112 52.6	− 0 24.0	+113 34.4	− 0 54.0
0 45	+115 20.9	+ 1 23.4	+116 01.9	+ 0 53.3	+116 42.3	+ 0 23.0
0 50	+118 03.0	+ 2 41.4	+118 43.0	+ 2 11.1	+119 22.6	+ 1 40.7
0 55	+120 24.6	+ 3 59.9	+121 04.0	+ 3 29.5	+121 43.0	+ 2 59.0
1 00	+122 30.9	+ 5 18.8	+123 09.9	+ 4 48.4	+123 48.6	+ 4 17.8
1 05	+124 25.4	+ 6 38.2	+125 04.1	+ 6 07.7	+125 42.5	+ 5 37.1
1 10	+126 10.6	+ 7 58.0	+126 49.1	+ 7 27.4	+127 27.3	+ 6 56.8
1 15	+127 48.3	+ 9 18.3	+128 26.6	+ 8 47.6	+129 04.7	+ 8 17.0
1 20	+129 20.1	+10 39.0	+129 58.2	+10 08.4	+130 36.1	+ 9 37.7
1 25	+130 47.1	+12 00.3	+131 25.0	+11 29.6	+132 02.8	+10 58.9
1 30	+132 10.2	+13 22.2	+132 48.0	+12 51.4	+133 25.6	+12 20.7
1 35	+133 30.4	+14 44.7	+134 08.0	+14 13.8	+134 45.5	+13 43.0
1 40	+134 48.5	+16 07.9	+135 25.9	+15 36.9	+136 03.1	+15 06.0
1 45	+136 05.1	+17 31.9	+136 42.3	+17 00.7	+137 19.3	+16 29.6
1 50	+137 20.9	+18 56.6	+137 57.8	+18 25.3	+138 34.6	+17 54.0
1 55	+138 36.5	+20 22.2	+139 13.1	+19 50.7	+139 49.6	+19 19.2
2 00	+139 52.6	+21 48.8	+140 28.9	+21 17.0	+141 05.0	+20 45.3
2 05	+141 09.8	+23 16.4	+141 45.7	+22 44.3	+142 21.5	+22 12.3
2 10	+142 28.8	+24 45.1	+143 04.3	+24 12.6	+143 39.6	+23 40.3
2 15	+143 50.4	+26 15.0	+144 25.3	+25 42.2	+145 00.1	+25 09.5
2 20	+145 15.4	+27 46.3	+145 49.7	+27 13.0	+146 23.9	+26 39.9
2 25	+146 44.6	+29 19.0	+147 18.2	+28 45.2	+147 51.7	+28 11.7
2 30	+148 19.2	+30 53.4	+148 51.9	+30 19.0	+149 24.5	+29 44.9
2 35	+150 00.5	+32 29.4	+150 32.1	+31 54.5	+151 03.7	+31 19.8
2 40	+151 49.8	+34 07.4	+152 20.2	+33 31.8	+152 50.5	+32 56.5
2 45	+153 49.2	+35 47.5	+154 18.0	+35 11.2	+154 46.9	+34 35.2
2 50	+156 01.0	+37 30.0	+156 27.9	+36 52.9	+156 54.9	+36 16.2
2 55	+158 28.3	+39 15.1	+158 52.8	+38 37.2	+159 17.6	+37 59.6
3 00	+161 15.4	+41 03.2	+161 36.9	+40 24.4	+161 58.8	+39 46.0
3 05	+164 28.3	+42 54.7	+164 45.9	+42 14.9	+165 04.0	+41 35.5
3 10	+168 15.9	+44 50.0	+168 28.2	+44 09.2	+168 41.3	+43 28.9
3 15	+172 52.8	+46 49.9	+172 57.6	+46 08.1	+173 03.8	+45 26.7
3 20	+178 45.0	+48 55.4	+178 38.5	+48 12.4	+178 34.2	+47 30.0
3 25	−173 08.6	+51 07.8	−173 35.4	+50 23.8	−173 58.2	+49 40.4
3 30	−159 07.7	+53 31.1	−160 36.4	+52 46.3	−161 50.9	+52 02.0
Limit	−142 11.5	+54 34.6	−142 15.9	+54 04.1	−142 20.2	+53 33.7

For duration, path width, and altitude and azimuth of the Sun, please see page 20, Local Circumstances for Points on the Central Line.

ELEMENTS OF THE ECLIPSE

U.T. of geocentric conjunction in right ascension, March 18^d 02^h 22^m $13^s.484$
Julian Day No. = 2447238.5987671760

	d h m		s
Right Ascension of Sun	23 51 35.692	Hourly Motion	9.131
Right Ascension of Moon	23 51 35.692	Hourly Motion	131.306
ΔT	+56.046		
	° ′ ″		′ ″
Declination of Sun	–0 54 39.08	Hourly Motion	+ 0 59.35
Declination of Moon	–0 25 36.77	Hourly Motion	+17 58.33
Equatorial hor. par. of Sun	8.83	True semidiameter of Sun	16 04.1
Equatorial hor. par. of Moon	60 45.43	True semidiameter of Moon	16 33.4
Lunar figure offset, latitude	–0.28		
" , longitude	+0.53		

CIRCUMSTANCES OF THE ECLIPSE

	U. T.	(– West) Longitude	Latitude
	d h m	° ′	° ′
Eclipse begins	March 17 23 24.0	+100 48.6	–13 22.6
Central eclipse begins	18 0 23.5	+ 86 05.4	– 4 21.9
Central eclipse at local apparent noon	2 22.2	+146 28.5	+27 53.9
Central eclipse ends	3 32.2	–142 15.9	+54 04.1
Eclipse ends	4 31.8	–156 49.2	+45 04.8

BESSELIAN ELEMENTS, POLYNOMIAL FORM

The equations below represent a simple least–squares fit to the tabular Besselian Elements. Do not use T outside the given range, and do not omit any terms in the series.

Let $T = (UT - 23^h)$. If T is negative, add 24 hours. These equations are valid over the range $0^h.300 \le T \le 5^h.692$.

$$
\begin{aligned}
x &= -1.69833348 + 0.50374325\,T + 0.00007255\,T^2 - 0.00000818\,T^3 \\
y &= -0.46580259 + 0.28033512\,T + 0.00002325\,T^2 - 0.00000475\,T^3 \\
\cos d &= -0.01684641 + 0.00027568\,T \\
\sin d &= 0.99985817 + 0.00000455\,T \\
\mu &= 162.95495962 + 15.00420735\,T + 0.00001167\,T^2 - 0.00000083\,T^3 \\
\text{Radius penumbra} &= 0.53794967 + 0.00013977\,T - 0.00001272\,T^2 \\
\text{Radius umbra} &= -0.00839403 + 0.00013923\,T - 0.00001274\,T^2 + 0.00000001\,T^3
\end{aligned}
$$

BESSELIAN ELEMENTS

U.T.	Intersection of Axis of Shadow with Fundamental Plane		Direction of Axis of Shadow			Radius of Shadow on Fundamental Plane	
h m	x	y	sin d	cos d	μ °	Penumbra	Umbra
22 50	-1.782288	-0.512524	-0.016892	0.999857	160.45422	0.537926	-0.008417
23 00	-1.698333	-0.465802	-0.016846	0.999858	162.95493	0.537950	-0.008394
10	1.614374	0.419079	.016800	.999859	165.45564	.537973	.008371
20	1.530411	0.372355	.016755	.999860	167.95635	.537995	.008349
30	1.446445	0.325630	.016709	.999860	170.45706	.538016	.008328
40	1.362475	0.278904	.016663	.999861	172.95777	.538037	.008307
50	1.278502	0.232177	.016617	.999862	175.45848	.538057	.008287
00 00	-1.194526	-0.185449	-0.016571	0.999863	177.95919	0.538077	-0.008268
10	1.110547	0.138721	.016525	.999863	180.45989	.538095	.008249
20	1.026566	0.091992	.016479	.999864	182.96059	.538113	.008231
30	0.942583	-0.045264	.016433	.999865	185.46130	.538131	.008214
40	0.858598	+0.001465	.016387	.999866	187.96200	.538147	.008197
50	0.774611	0.048194	.016341	.999866	190.46270	.538163	.008182
01 00	-0.690622	+0.094923	-0.016295	0.999867	192.96341	0.538178	-0.008166
10	0.606632	0.141651	.016249	.999868	195.46412	.538193	.008152
20	0.522641	0.188379	.016203	.999869	197.96482	.538207	.008138
30	0.438650	0.235106	.016157	.999869	200.46553	.538220	.008125
40	0.354657	0.281833	.016111	.999870	202.96624	.538232	.008113
50	0.270665	0.328559	.016065	.999871	205.46695	.538244	.008102
02 00	-0.186672	+0.375284	-0.016019	0.999872	207.96767	0.538254	-0.008091
10	0.102679	0.422008	.015973	.999872	210.46838	.538265	.008081
20	-0.018686	0.468730	.015927	.999873	212.96908	.538274	.008071
30	+0.065306	0.515451	.015882	.999874	215.46979	.538283	.008062
40	0.149297	0.562171	.015836	.999875	217.97050	.538291	.008054
50	0.233288	0.608889	.015790	.999875	220.47121	.538298	.008047
03 00	+0.317277	+0.655606	-0.015744	0.999876	222.97192	0.538305	-0.008040
10	0.401265	0.702320	.015698	.999877	225.47263	.538311	.008034
20	0.485251	0.749033	.015652	.999878	227.97334	.538316	.008029
30	0.569235	0.795743	.015606	.999878	230.47405	.538321	.008025
40	0.653217	0.842451	.015560	.999879	232.97476	.538325	.008021
50	0.737197	0.889157	.015514	.999880	235.47547	.538328	.008018
04 00	+0.821174	0.935860	-0.015468	0.999880	237.97618	0.538330	-0.008015
10	0.905149	0.982561	.015422	.999881	240.47689	.538332	.008014
20	0.989120	1.029258	.015376	.999882	242.97760	.538333	.008013
30	1.073089	1.075953	.015330	.999882	245.47831	.538333	.008012
40	1.157053	1.122645	.015284	.999883	247.97903	.538333	.008013
50	1.241014	1.169333	.015238	.999884	250.47974	.538332	.008014
05 00	+1.324972	+1.216018	-0.015192	0.999885	252.98045	0.538330	-0.008016
10	1.408925	1.262700	.015146	.999885	255.48116	.538328	.008018
05 20	+1.492873	+1.309378	-0.015100	0.999886	257.98187	0.538324	-0.008021

tan f1	0.004697
tan f2	0.004674
μ'	0.261874 radians/hr
d'	0.000276 radians/hr

LOCAL CIRCUMSTANCES FOR POINTS ON THE CENTRAL LINE

Maximum Eclipse					Central Line		First Contact		
U.T.	Duration	Path Width	Alt.	Az.	Longitude	Latitude	U.T.	P	V
h m	m s	km	°	°	° '	° '	h m s	°	°
0 25	2 00.0	128	9	90	+ 95 00.0	− 4 06.8	.. ..	...	...
0 30	2 20.3	142	19	90	+103 50.2	− 2 55.5	23 29 00.5	239	331
0 35	2 34.0	151	26	90	+109 00.1	− 1 40.4	23 31 20.6	237	328
0 40	2 45.1	158	31	91	+112 52.5	− 0 24.0	23 34 09.2	236	326
0 45	2 54.7	163	35	92	+116 01.9	+ 0 53.2	23 37 15.1	234	323
0 50	3 03.1	167	39	93	+118 43.0	+ 2 11.1	23 40 33.3	233	321
0 55	3 10.5	170	43	94	+121 04.0	+ 3 29.5	23 44 01.3	232	318
1 00	3 17.2	173	46	96	+123 09.9	+ 4 48.3	23 47 37.6	231	315
1 05	3 23.1	175	49	98	+125 04.1	+ 6 07.6	23 51 21.1	231	313
1 10	3 28.4	176	51	101	+126 49.0	+ 7 27.4	23 55 11.3	230	310
1 15	3 33.0	177	54	104	+128 26.6	+ 8 47.6	23 59 07.6	229	308
1 20	3 37.1	177	56	107	+129 58.2	+10 08.3	0 03 09.7	228	305
1 25	3 40.6	177	58	111	+131 25.0	+11 29.6	0 07 17.4	228	302
1 30	3 43.6	177	60	115	+132 48.0	+12 51.4	0 11 30.5	227	299
1 35	3 46.0	176	62	120	+134 08.0	+14 13.8	0 15 48.9	227	296
1 40	3 47.9	176	63	126	+135 25.8	+15 36.9	0 20 12.5	226	293
1 45	3 49.3	175	64	132	+136 42.2	+17 00.6	0 24 41.4	226	289
1 50	3 50.2	174	65	138	+137 57.7	+18 25.2	0 29 15.4	225	286
1 55	3 50.6	172	65	145	+139 13.1	+19 50.6	0 33 54.7	225	282
2 00	3 50.5	171	65	152	+140 28.8	+21 16.9	0 38 39.2	225	278
2 05	3 49.9	170	65	158	+141 45.6	+22 44.2	0 43 29.1	225	274
2 10	3 48.8	168	64	165	+143 04.2	+24 12.6	0 48 24.4	225	269
2 15	3 47.2	167	63	171	+144 25.3	+25 42.1	0 53 25.4	225	264
2 20	3 45.1	165	62	177	+145 49.6	+27 13.0	0 58 32.2	225	260
2 25	3 42.5	164	60	183	+147 18.1	+28 45.2	1 03 45.1	225	255
2 30	3 39.4	162	59	188	+148 51.9	+30 19.0	1 09 04.3	225	250
2 35	3 35.8	160	56	193	+150 32.0	+31 54.4	1 14 30.1	225	245
2 40	3 31.6	159	54	198	+152 20.1	+33 31.8	1 20 03.1	226	240
2 45	3 26.9	157	52	202	+154 18.0	+35 11.2	1 25 43.6	226	235
2 50	3 21.5	154	49	206	+156 27.8	+36 52.9	1 31 32.3	227	230
2 55	3 15.5	152	46	211	+158 52.8	+38 37.1	1 37 30.1	227	226
3 00	3 08.9	150	43	215	+161 36.9	+40 24.3	1 43 37.9	228	222
3 05	3 01.4	147	40	219	+164 45.8	+42 14.8	1 49 57.2	229	218
3 10	2 53.1	144	36	223	+168 28.2	+44 09.2	1 56 30.1	230	215
3 15	2 43.7	140	31	228	+172 57.5	+46 08.0	2 03 19.7	231	212
3 20	2 32.9	136	26	234	+178 38.5	+48 12.4	2 10 31.7	232	209
3 25	2 19.7	131	20	242	−173 35.3	+50 23.8	2 18 18.4	234	207
3 30	2 01.3	123	11	253	−160 36.4	+52 46.2	2 27 23.4	237	205

The magnitude is 1 or greater and the obscuration is 100% for all points.

LOCAL CIRCUMSTANCES FOR POINTS ON THE CENTRAL LINE

U.T. at Maximum	Second Contact U.T.	P	V	Third Contact U.T.	P	V	Fourth Contact U.T.	P	V
h m	h m s	°	°	h m s	°	°	h m s	°	°
0 25	0 24 00.2	59	153	0 26 00.2	239	333	1 28 13.4	57	151
0 30	0 28 50.0	57	149	0 31 10.4	236	329	1 38 03.8	54	147
0 35	0 33 43.2	55	146	0 36 17.3	235	326	1 46 10.8	52	144
0 40	0 38 37.7	53	143	0 41 22.9	233	323	1 53 36.9	50	140
0 45	0 43 32.9	52	140	0 46 27.6	232	320	2 00 37.2	49	136
0 50	0 48 28.7	51	137	0 51 31.9	231	317	2 07 18.4	48	132
0 55	0 53 25.0	50	134	0 56 35.6	230	314	2 13 44.3	47	128
1 00	0 58 21.7	49	131	1 01 38.9	229	311	2 19 57.2	46	122
1 05	1 03 18.7	48	128	1 06 41.9	228	307	2 25 58.8	45	116
1 10	1 08 16.1	47	124	1 11 44.5	227	304	2 31 50.4	45	109
1 15	1 13 13.7	46	120	1 16 46.8	226	300	2 37 32.9	44	99
1 20	1 18 11.7	46	116	1 21 48.8	226	296	2 43 07.0	44	89
1 25	1 23 09.9	45	112	1 26 50.6	225	291	2 48 33.5	43	77
1 30	1 28 08.4	45	107	1 31 52.0	225	286	2 53 52.7	43	65
1 35	1 33 07.2	44	102	1 36 53.2	224	281	2 59 05.1	43	54
1 40	1 38 06.2	44	96	1 41 54.1	224	275	3 04 11.1	43	45
1 45	1 43 05.5	44	90	1 46 54.8	224	269	3 09 11.0	43	36
1 50	1 48 05.0	44	84	1 51 55.2	224	262	3 14 04.9	43	30
1 55	1 53 04.8	43	77	1 56 55.4	223	256	3 18 53.2	43	25
2 00	1 58 04.8	43	71	2 01 55.3	223	249	3 23 35.8	43	21
2 05	2 03 05.1	43	64	2 06 55.0	223	242	3 28 13.1	43	18
2 10	2 08 05.6	44	58	2 11 54.5	224	236	3 32 44.9	44	15
2 15	2 13 06.4	44	52	2 16 53.6	224	231	3 37 11.5	44	14
2 20	2 18 07.4	44	47	2 21 52.6	224	225	3 41 32.7	44	12
2 25	2 23 08.7	44	42	2 26 51.3	224	221	3 45 48.6	45	11
2 30	2 28 10.2	45	38	2 31 49.7	225	217	3 49 59.0	45	11
2 35	2 33 12.0	45	35	2 36 47.8	225	213	3 54 04.0	46	10
2 40	2 38 14.1	46	32	2 41 45.7	226	210	3 58 03.2	47	10
2 45	2 43 16.4	46	29	2 46 43.3	226	208	4 01 56.6	48	10
2 50	2 48 19.1	47	27	2 51 40.7	227	206	4 05 43.7	48	11
2 55	2 53 22.1	48	25	2 56 37.7	228	204	4 09 24.1	49	11
3 00	2 58 25.4	49	23	3 01 34.3	229	203	4 12 57.1	50	12
3 05	3 03 29.1	50	22	3 06 30.6	230	202	4 16 21.8	51	13
3 10	3 08 33.3	51	21	3 11 26.4	231	201	4 19 36.6	52	14
3 15	3 13 38.0	52	21	3 16 21.7	232	201	4 22 39.2	54	15
3 20	3 18 43.4	54	21	3 21 16.3	234	201	4 25 25.0	55	16
3 25	3 23 50.0	55	21	3 26 09.7	235	201	4 27 43.7	57	18
3 30	3 28 59.2	58	22	3 31 00.5	238	202	4 28 58.5	59	22

LOCAL CIRCUMSTANCES FOR GEOGRAPHIC LOCATIONS

Position Longitude	Latitude	Name of Location	Duration of Totality	Path Width	Maximum Eclipse U.T.	Max. Obscur.	Mag.	Sun's Alt.	Az.
° '	° '		m s	km	h m s	%		°	°
-150 00.0	+61 10.0	Anchorage, Alaska, U.S.A.			3 25 40.3	75.5	0.801	4	260
-174 15.0	+52 14.0	Atka, Alaska, U.S.A.			3 23 54.6	95.6	0.958	20	240
+116 50.0	- 1 15.0	Balikpapan, Borneo, Indonesia			0 42 48.5	95.1	0.953	36	90
+114 58.0	+ 4 56.0	Bandar Seri Begawan, Brunei			0 49 56.4	89.2	0.907	35	95
+107 34.0	- 6 57.0	Bandung, Java, Indonesia			0 28 11.1	85.7	0.880	23	88
+102 16.0	- 3 47.5	Bangkahulu, Sumatra, Indonesia	0 59.3	139	0 28 13.7	100.0	1.002	17	90
+100 30.0	+13 44.0	Bangkok, Thailand			0 49 40.2	47.9	0.573	20	96
+114 33.0	- 3 22.0	Banjarmasin, Borneo, Indonesia			0 37 43.0	91.2	0.922	32	89
+105 45.5	- 1 38.0	Belinju, Pulau Bangka, Indonesia			0 32 39.1	98.5	0.982	22	90
+ 72 51.0	+18 56.0	Bombay, India			.. ..	... .	. ...	...	...
+107 37.0	- 6 49.5	Bosscha Obs., Java, Indonesia			0 28 20.5	86.1	0.883	23	88
+125 10.5	+ 6 06.5	Buayan / Gen. Santos, Philippines	3 22.4	175	1 05 07.0	100.0	1.020	49	98
+ 88 20.0	+22 30.0	Calcutta, India			0 55 53.4	22.6	0.339	9	95
+113 20.0	+23 08.0	Canton, P.R.C.			1 20 12.6	40.1	0.505	37	110
+113 43.0	-24 53.0	Carnarvan Radio Obs., Australia			0 19 17.8	17.8	0.287	24	79
+106 35.0	+29 30.0	Chungking, P.R.C.			1 23 43.5	21.5	0.327	30	110
+ 79 52.0	+ 6 55.0	Colombo, Sri Lanka			.. ..	... .	. ...	...	...
+124 14.5	+ 7 14.0	Cotabato, Philippines			1 05 49.1	98.4	0.981	48	100
+ 90 22.0	+23 42.0	Dacca, Bangladesh			0 58 53.4	21.0	0.321	12	96
+130 44.0	-12 23.0	Darwin, N. Territory, Australia			0 43 24.9	35.3	0.461	48	77
+125 37.0	+ 7 05.0	Davao, Philippines	2 50.8	176	1 07 32.0	100.0	1.010	50	100
-139 24.0	+64 04.0	Dawson, Yukon, Canada			.. ..	... .	. ...	...	...
+ 77 14.0	+28 40.0	Delhi, India			1 02 08.7	11.5	0.214	0	91
+124 30.0	+ 7 01.0	Dulawan, Philippines			1 05 47.7	99.3	0.990	48	99
+144 45.0	+13 30.0	Guam			1 51 38.3	71.9	0.769	73	146
+106 43.0	+10 46.0	Ho Chi Minh City, Vietnam			0 50 26.8	61.4	0.686	27	97
+122 33.0	+10 41.0	Iloilo, Philippines			1 09 43.7	85.8	0.880	47	103
+104 20.7	+52 16.7	Irkutsk Astro. Obs., U.S.S.R.			2 02 56.2	2.6	0.077	24	127
+106 45.0	- 6 08.0	Jakarta, Java, Indonesia			0 28 28.6	89.3	0.908	22	89
+ 78 43.7	+17 05.9	Japal-Rangapur Obs., India			.. ..	... .	. ...	...	...
+110 24.0	- 7 48.0	Jogyakarta, Java, Indonesia			0 29 15.5	80.1	0.835	26	87
-134 25.0	+58 18.0	Juneau, Alaska, U.S.A.			.. ..	... .	. ...	...	...
+102 35.0	- 3 38.5	Kepahiang, Sumatra, Indonesia	1 30.8	139	0 28 32.8	100.0	1.005	18	90
+109 58.0	- 1 51.5	Ketapang, Borneo, Indonesia	1 57.9	152	0 35 33.3	100.0	1.007	27	90
+101 42.0	+ 3 08.0	Kuala Lumpur, Malaysia			0 35 39.7	80.7	0.840	18	92
+110 20.0	+ 1 32.0	Kuching, Sarawak, Malaysia			0 40 14.6	94.0	0.945	28	92
+103 32.5	- 3 47.0	Lahat, Sumatra, Indonesia			0 28 55.9	99.1	0.989	19	90
+125 38.5	+ 6 18.5	Lais, Philippines	3 18.4	175	1 06 09.1	100.0	1.017	50	99
+150 50.0	+59 38.0	Magadan, U.S.S.R.			2 56 06.7	36.7	0.474	29	195
+120 58.0	+14 37.0	Manila, Philippines			1 14 49.5	72.2	0.773	45	107
+120 34.8	+16 24.7	Manila Obs. (Baguio), Philippines			1 17 41.3	67.0	0.731	45	109
+121 04.6	+14 38.2	Manila Obs. (Quezon), Philippines			1 15 01.5	72.4	0.774	45	107
+126 13.0	+ 6 57.0	Mati, Philippines	3 26.4	176	1 08 10.0	100.0	1.022	51	100
-177 24.0	+28 12.0	Midway Islands			3 17 59.8	27.2	0.385	34	248
+102 12.0	- 3 07.0	Muaraaman, Sumatra, Indonesia	2 14.2	140	0 28 52.6	100.0	1.015	17	90
+103 02.5	- 3 14.5	Muarabeliti, Sumatra, Indonesia	2 13.8	141	0 29 12.5	100.0	1.014	18	90
+105 09.5	- 2 04.0	Muntok, Pulau Bangka, Indonesia	1 11.5	145	0 31 45.6	100.0	1.002	21	90
+129 52.0	+32 45.0	Nagasaki, Japan			2 03 30.5	51.9	0.607	51	145
+111 45.0	- 0 19.0	Nangpinch, Borneo, Indonesia	2 03.2	157	0 39 03.7	100.0	1.007	29	91
+118 47.0	+32 03.0	Nanking, P.R.C.			1 45 06.3	32.7	0.438	42	126

Assumed to be sea level.

Names and spellings are not authoritative, nor do they imply any official recognition of status.

No correction for elevation or limb included.

LOCAL CIRCUMSTANCES FOR GEOGRAPHIC LOCATIONS

Position		First Contact			Second Contact			Third Contact			Fourth Contact		
Longitude	Latitude	U.T.	P	V	U.T.	P	V	U.T.	P	V	U.T.	P	V
° ′	° ′	h m s	°	°	h m s	°	°	h m s	°	°	h m s	°	°
-150 00.0	+61 10.0	2 27 56.7	227	200							.. ..	...	...
-174 15.0	+52 14.0	2 17 40.6	231	206							4 26 25.1	60	24
+116 50.0	- 1 15.0	23 35 15.7	238	329							1 58 08.1	45	136
+114 58.0	+ 4 56.0	23 42 14.8	228	313							2 05 28.2	56	136
+107 34.0	- 6 57.0	23 26 43.7	246	342							1 36 37.5	45	144
+102 16.0	- 3 47.5	23 28 05.5	240	334	0 27 44.1	121	215	0 28 43.5	173	267	1 35 14.9	54	148
+100 30.0	+13 44.0	23 53 13.9	212	288							1 51 59.7	80	153
+114 33.0	- 3 22.0	23 31 56.7	241	334							1 51 06.2	45	139
+105 45.5	- 1 38.0	23 30 33.6	237	328							1 42 02.3	55	146
+ 72 51.0	+18 56.0	.. ..	...	...							1 33 19.0	98	169
+107 37.0	- 6 49.5	23 26 48.9	245	342							1 36 52.1	46	144
+125 10.5	+ 6 06.5	23 51 25.2	231	313	1 03 26.1	54	133	1 06 48.5	222	302	2 26 08.1	45	116
+ 88 20.0	+22 30.0	.. ..	...	...							1 43 17.3	100	165
+113 20.0	+23 08.0	0 18 56.7	203	267							2 26 44.8	79	130
+113 43.0	-24 53.0	23 35 41.4	282	38							1 05 43.5	8	127
+106 35.0	+29 30.0	0 33 19.5	192	250							2 17 40.3	95	143
+ 79 52.0	+ 6 55.0	.. ..	...	...							1 28 32.5	79	162
+124 14.5	+ 7 14.0	23 52 23.9	229	310							2 26 35.9	48	116
+ 90 22.0	+23 42.0	0 14 56.2	197	263							1 46 06.8	100	164
+130 44.0	-12 23.0	23 42 57.3	263	8							1 48 39.2	13	129
+125 37.0	+ 7 05.0	23 53 24.3	230	311	1 06 06.9	14	92	1 08 57.7	261	339	2 28 52.5	46	113
-139 24.0	+64 04.0	2 28 33.1	224	198							.. ..	...	...
+ 77 14.0	+28 40.0	.. ..	...	...							1 38 22.0	112	173
+124 30.0	+ 7 01.0	23 52 16.2	229	310							2 26 40.0	47	116
+144 45.0	+13 30.0	0 31 29.8	238	301							3 13 58.8	27	350
+106 43.0	+10 46.0	23 48 51.9	217	296							1 58 55.3	71	145
+122 33.0	+10 41.0	23 57 05.2	223	300							2 29 34.9	54	116
+104 20.7	+52 16.7	1 37 13.2	168	200							2 29 04.5	122	149
+106 45.0	- 6 08.0	23 27 02.6	244	340							1 36 56.2	47	144
+ 78 43.7	+17 05.9	.. ..	...	...							1 33 59.6	94	167
+110 24.0	- 7 48.0	23 27 05.2	247	345							1 38 26.0	42	142
-134 25.0	+58 18.0	2 32 47.0	234	202							.. ..	...	...
+102 35.0	- 3 38.5	23 28 14.6	240	333	0 27 47.6	106	199	0 29 18.4	189	282	1 35 46.3	54	148
+109 58.0	- 1 51.5	23 31 28.0	237	329	0 34 34.5	95	187	0 36 32.5	193	285	1 47 12.7	51	143
+101 42.0	+ 3 08.0	23 35 29.7	229	315							1 42 47.0	64	150
+110 20.0	+ 1 32.0	23 35 26.7	232	320							1 52 44.3	55	142
+103 32.5	- 3 47.0	23 28 14.0	240	334							1 36 37.6	53	147
+125 38.5	+ 6 18.5	23 52 10.5	231	313	1 04 30.2	62	141	1 07 48.6	213	292	2 27 23.0	45	114
+150 50.0	+59 38.0	1 57 56.0	201	202							3 53 27.9	86	71
+120 58.0	+14 37.0	0 03 42.3	217	290							2 32 44.8	60	115
+120 34.8	+16 24.7	0 07 16.0	215	286							2 34 38.7	63	115
+121 04.6	+14 38.2	0 03 49.5	217	290							2 33 01.1	60	115
+126 13.0	+ 6 57.0	23 53 45.7	230	311	1 06 27.1	50	128	1 09 53.6	225	303	2 29 43.0	45	111
-177 24.0	+28 12.0	2 19 25.7	268	222							4 12 35.8	15	316
+102 12.0	- 3 07.0	23 28 39.2	239	332	0 27 45.6	47	140	0 29 59.9	247	340	1 36 01.0	55	148
+103 02.5	- 3 14.5	23 28 37.8	239	332	0 28 05.8	71	165	0 30 19.6	222	315	1 36 46.3	54	147
+105 09.5	- 2 04.0	23 30 01.1	237	329	0 31 10.0	356	88	0 32 21.6	296	28	1 40 43.7	54	146
+129 52.0	+32 45.0	0 52 49.1	204	248							3 16 49.9	70	74
+111 45.0	- 0 19.0	23 33 46.3	235	325	0 38 02.3	13	103	0 40 05.5	274	4	1 52 04.8	52	141
+118 47.0	+32 03.0	0 44 25.9	196	248							2 49 20.6	83	112

Dot leaders indicate the phenomenon occurs below the horizon. Blanks indicate the phenomenon does not occur for the location.

LOCAL CIRCUMSTANCES FOR GEOGRAPHIC LOCATIONS

Position		Name of Location	Duration of Totality	Path Width	Maximum Eclipse				
Longitude	Latitude				U.T.	Max. Obscur.	Mag.	Sun's Alt.	Sun's Az.
° '	° '		m s	km	h m s	%		°	°
+128 27.4	+36 56.0	National Obs., S. Korea			2 08 19.6	41.7	0.519	47	147
+138 28.9	+35 56.3	Nobeyama Solar Radio Obs., Japan			2 22 07.5	64.6	0.711	52	167
-165 30.0	+64 30.0	Nome, Alaska, U.S.A.			3 19 20.5	59.2	0.669	11	244
+137 33.3	+36 06.8	Norikura Solar Obs., Japan			2 20 57.7	62.2	0.691	52	165
+ 76 40.0	+11 22.9	Ootacamund Radio Obs., India			.. ..	... .	. ...	...	...
+135 30.0	+34 40.0	Osaka, Japan			2 15 33.9	60.5	0.678	53	159
+121 04.3	+14 39.2	PAGASA Obs., Philippines			1 15 03.0	72.3	0.773	45	107
+100 21.0	- 1 00.0	Padang, Sumatra, Indonesia			0 30 07.5	94.1	0.946	16	91
+104 46.0	- 2 59.0	Palembang, Sumatra, Indonesia	2 12.1	143	0 30 30.2	100.0	1.012	20	90
+106 06.5	- 2 08.0	Pangkalpinang, Pulau Bangka, Indo.	2 11.4	147	0 32 19.3	100.0	1.011	22	90
+116 26.0	+39 55.0	Peking, P.R.C.			1 55 56.4	19.4	0.304	37	131
+104 14.5	- 3 26.5	Perabumulih, Sumatra, Indonesia	0 58.2	142	0 29 41.7	100.0	1.002	20	90
+158 43.0	+53 03.0	Petropavlovsk-Kamchatskiy, U.S.S.R.			3 02 18.0	61.4	0.686	33	207
+104 55.0	+11 35.0	Phnom Penh, Cambodia			0 50 02.9	57.3	0.652	25	96
+104 48.5	- 3 00.0	Pladju, Sumatra, Indonesia	2 09.8	143	0 30 30.7	100.0	1.011	20	90
+109 16.0	- 0 05.0	Pontianak, Borneo, Indonesia			0 37 11.5	97.3	0.972	27	91
+147 07.0	- 9 30.0	Port Moresby, Papua New Guinea			1 09 37.8	11.1	0.207	71	65
+118 49.3	+32 04.0	Purple Mountain Obs., P.R.C.			1 45 11.6	32.8	0.438	42	126
+ 96 10.0	+16 47.0	Rangoon, Burma			0 51 17.2	37.7	0.483	16	96
+114 10.3	+22 18.2	Royal Obs., Kowloon, Hong Kong			1 19 46.3	42.9	0.530	38	110
+110 31.5	- 1 15.0	Sandae, Borneo, Indonesia	2 38.0	154	0 36 46.6	100.0	1.019	28	90
+141 21.0	+43 05.0	Sapporo, Japan			2 35 29.9	55.5	0.637	46	177
+127 00.0	+37 30.0	Seoul, S. Korea			2 07 03.0	38.2	0.487	46	145
+121 25.6	+31 11.4	Shanghai Obs., P.R.C.			1 47 29.3	38.4	0.490	45	129
+103 49.0	+ 1 19.0	Singapore			0 34 49.0	88.4	0.901	20	91
+111 30.0	+ 0 05.0	Sintang, Borneo, Indonesia			0 39 21.7	99.4	0.991	29	91
+104 51.0	- 2 59.5	Sungaigerong, Sumatra, Indonesia	2 09.9	143	0 30 32.8	100.0	1.011	20	90
+106 06.5	- 1 51.5	Sungailiat, Pulau Bangka, Indonesia	1 18.8	147	0 32 38.1	100.0	1.003	22	90
+112 45.0	- 7 14.0	Surabaya, Java, Indonesia			0 31 37.5	79.7	0.832	29	87
+121 31.6	+25 04.7	Taipei Obs., Taiwan			1 35 59.9	49.7	0.588	46	121
+107 38.0	- 2 44.5	Tandjungpandan, Pulau Belitung, Indo.	0 11.0	147	0 32 42.3	100.0	1.000	24	90
+117 29.5	+ 2 10.5	Tandjungredeb, Borneo, Indonesia	2 03.6	166	0 48 33.0	100.0	1.006	38	93
+117 21.5	+ 2 50.0	Tanjungselor, Borneo, Indonesia			0 49 24.6	98.9	0.986	38	93
+103 05.5	- 3 35.0	Tebingtinggi, Sumatra, Indonesia	1 23.5	140	0 28 53.1	100.0	1.004	18	90
+106 27.3	- 3 01.0	Toboali, Pulau Bangka, Indonesia	0 27.3	146	0 31 34.1	100.0	1.000	22	90
+139 45.0	+35 40.0	Tokyo, Japan			2 23 40.4	68.1	0.740	53	169
+119 28.0	- 5 09.0	Ujung Pandang, Sulawesi, Indonesia			0 40 18.2	78.2	0.820	37	87
+106 52.0	+47 54.0	Ulaanbaatar, Mongolia			1 58 04.1	5.3	0.126	27	127
+ 79 27.4	+29 21.6	Uttar Pradesh State Obs., India			1 03 46.6	10.6	0.202	2	92
+ 73 42.8	+24 35.1	Vedhshala Solar Obs., India			.. ..	... .	. ...	...	...
+102 38.0	+17 59.0	Vientiane, Laos			0 58 25.9	39.1	0.496	24	99
+131 53.0	+43 09.0	Vladivostok, U.S.S.R.			2 22 28.7	37.9	0.485	44	160
+166 35.0	+19 18.0	Wake Island			2 42 15.2	28.4	0.396	58	233
+129 50.0	+62 10.0	Yakutsk, U.S.S.R.			2 38 53.5	13.8	0.241	26	166
+102 47.3	+25 01.5	Yunnan Obs., P.R.C.			1 11 05.4	25.2	0.365	25	104

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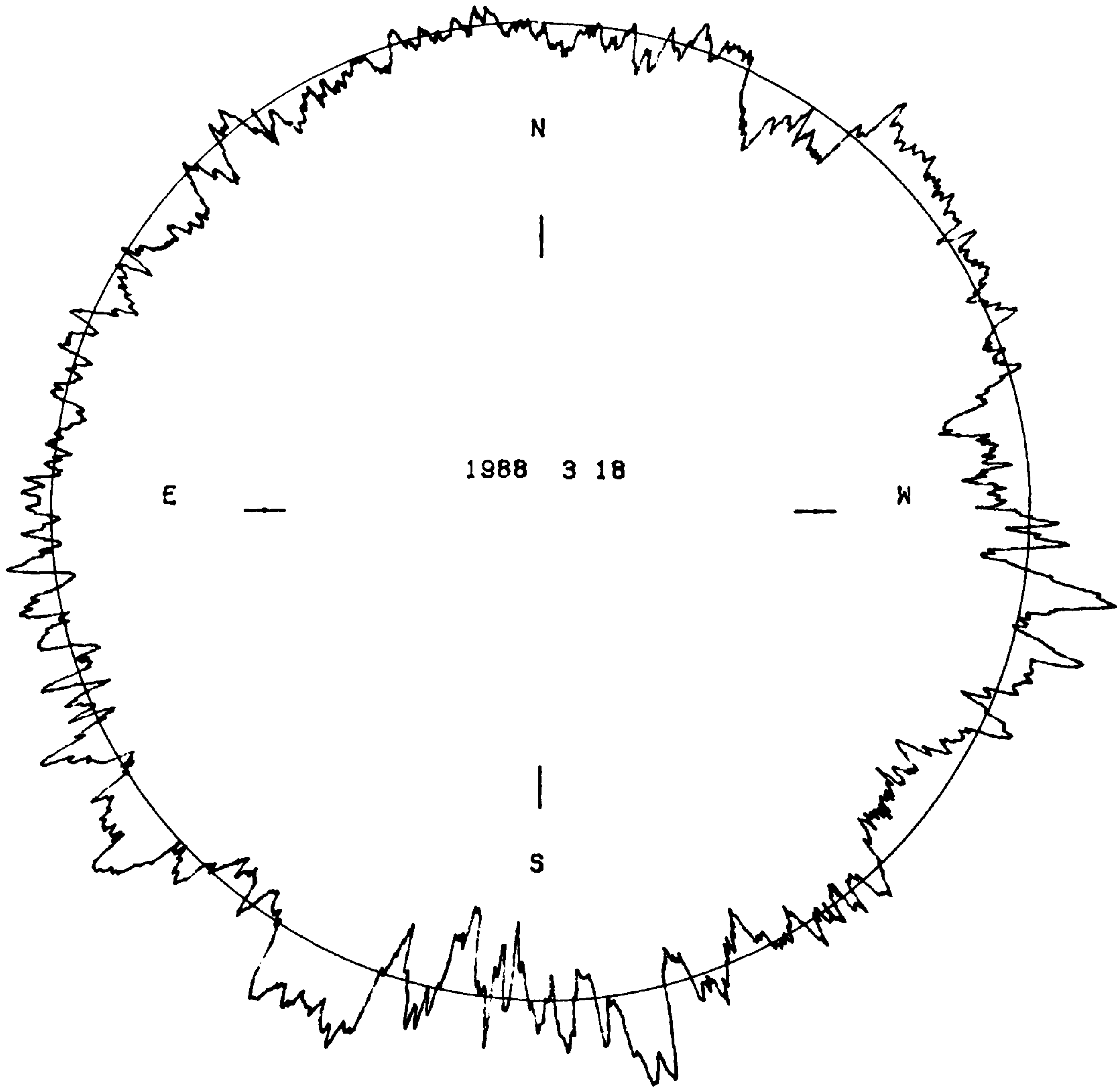
LOCAL CIRCUMSTANCES FOR GEOGRAPHIC LOCATIONS

Position		First Contact			Second Contact			Third Contact			Fourth Contact		
Longitude	Latitude	U.T.	P	V	U.T.	P	V	U.T.	P	V	U.T.	P	V
° '	° '	h m s	°	°	h m s	°	°	h m s	°	°	h m s	°	°
+128 27.4	+36 56.0	1 01 55.4	200	239							3 16 54.5	77	82
+138 28.9	+35 56.3	1 07 30.6	210	241							3 37 33.4	64	50
-165 30.0	+64 30.0	2 21 36.7	217	198							4 14 57.5	79	54
+137 33.3	+36 06.8	1 07 01.1	209	241							3 35 52.4	65	53
+ 76 40.0	+11 22.9	.. ..	...	...							1 30 15.7	86	164
+135 30.0	+34 40.0	1 01 55.9	208	244							3 30 41.2	66	57
+121 04.3	+14 39.2	0 03 51.4	217	290							2 33 02.0	60	115
+100 21.0	- 1 00.0	23 30 31.4	235	326							1 36 33.2	59	150
+104 46.0	- 2 59.0	23 29 05.9	239	332	0 29 24.4	78	171	0 31 36.5	214	307	1 39 03.3	53	146
+106 06.5	- 2 08.0	23 30 08.4	237	329	0 31 13.8	30	121	0 33 25.3	262	354	1 41 48.1	54	146
+116 26.0	+39 55.0	1 04 18.0	188	230							2 49 47.1	94	119
+104 14.5	- 3 26.5	23 28 36.9	239	333	0 29 12.7	122	215	0 30 11.0	171	264	1 37 51.0	53	147
+158 43.0	+53 03.0	1 55 01.5	212	208							4 07 34.0	72	47
+104 55.0	+11 35.0	23 49 55.1	216	294							1 56 48.3	74	148
+104 48.5	- 3 00.0	23 29 05.4	239	332	0 29 26.0	81	174	0 31 35.8	212	305	1 39 04.9	53	146
+109 16.0	- 0 05.0	23 33 08.3	234	324							1 48 50.8	54	143
+147 07.0	- 9 30.0	0 20 52.1	277	24							2 00 04.4	349	139
+118 49.3	+32 04.0	0 44 29.6	196	248							2 49 27.3	83	112
+ 96 10.0	+16 47.0	23 59 03.9	207	281							1 48 28.9	87	157
+114 10.3	+22 18.2	0 17 16.2	204	269							2 27 44.6	78	128
+110 31.5	- 1 15.0	23 32 17.2	236	328	0 35 27.8	57	148	0 38 05.9	231	322	1 48 53.8	51	142
+141 21.0	+43 05.0	1 24 54.5	206	226							3 45 57.7	70	54
+127 00.0	+37 30.0	1 02 26.0	198	237							3 13 54.2	79	87
+121 25.6	+31 11.4	0 43 31.2	199	250							2 55 07.0	79	104
+103 49.0	+ 1 19.0	23 33 28.8	232	320							1 43 20.5	60	148
+111 30.0	+ 0 05.0	23 34 07.8	235	324							1 52 19.5	52	141
+104 51.0	- 2 59.5	23 29 06.2	239	332	0 29 28.0	81	174	0 31 38.0	212	305	1 39 08.4	53	146
+106 06.5	- 1 51.5	23 30 24.6	237	329	0 31 58.9	358	90	0 33 17.7	293	25	1 42 10.4	54	146
+112 45.0	- 7 14.0	23 28 17.6	247	344							1 42 06.2	41	140
+121 31.6	+25 04.7	0 28 10.5	205	265							2 48 40.5	72	105
+107 38.0	- 2 44.5	23 29 55.3	238	331	0 32 37.0	141	234	0 32 48.0	150	242	1 42 51.8	52	144
+117 29.5	+ 2 10.5	23 39 45.3	233	320	0 47 31.4	5	91	0 49 35.1	278	4	2 05 13.8	49	134
+117 21.5	+ 2 50.0	23 40 33.7	232	319							2 06 08.8	50	134
+103 05.5	- 3 35.0	23 28 20.7	240	333	0 28 11.5	110	203	0 29 35.0	184	277	1 36 23.6	54	147
+106 27.3	- 3 01.0	23 29 23.5	239	332	0 31 20.5	135	228	0 31 47.9	157	249	1 41 01.1	52	145
+139 45.0	+35 40.0	1 08 10.5	211	241							3 39 46.6	62	45
+119 28.0	- 5 09.0	23 33 27.1	245	340							1 54 30.2	37	135
+106 52.0	+47 54.0	1 25 02.1	173	209							2 31 57.5	114	143
+ 79 27.4	+29 21.6	.. ..	...	...							1 39 39.8	113	173
+ 73 42.8	+24 35.1	.. ..	...	...							1 35 49.[illegible]	106	172
+102 38.0	+17 59.0	0 02 51.9	206	278							1 59 25.5	84	150
+131 53.0	+43 09.0	1 18 26.4	198	226							3 27 37.5	80	78
+166 35.0	+19 18.0	1 36 09.7	261	239							3 45 32.0	9	307
+129 50.0	+62 10.0	1 55 10.8	184	196							3 22 50.9	104	104
+102 47.3	+25 01.5	0 20 17.5	196	260							2 05 59.7	93	150

Dot leaders indicate the phenomenon occurs below the horizon. Blanks indicate the phenomenon does not occur for the location.

LUNAR LIMB PROFILE

true limb: *heavy line*
mean limb: *light line*



LIMB CORRECTIONS

The information below is based largely on the article "Correcting Predictions of Solar Eclipse Contact Times for the Effects of Lunar Limb Irregularities", *J. Brit. astron. Assoc. 1983*, 93, 6, pp. 241–246, by David Herald, of Canberra, A. C. T., Australia. Mr. Herald has provided graphical charts to convert the lunar limb profile diagram to corrections to times of contacts for several previous eclipses. His new, improved charts for this eclipse appear overleaf.

For locations in the central path of a solar eclipse, predicted times of second and third contacts are computed on the assumption that the Moon is a smooth circular body. However, in a strict sense this is not true, and, in particular, the irregular limb of the Moon introduces a change into those predicted contact times which may potentially amount to several seconds at locations well away from the central line. To reduce the effect, corrections have been applied to the lunar ephemeris for the offset of the center of figure from the center of mass (or motion), and a mean lunar profile radius k has been used in the calculations.

Second and third contacts are defined as the instants at which the solar limb is tangential to the lunar limb, but does not intersect it at any point. In the strictest sense, then, of applying this definition to the irregular true lunar limb, one can see by inspection of the profile (facing page) that for any given point of predicted contact on the smooth mean limb, there is some irregular valley feature in the vicinity whose innermost (deepest) point will define the true contact. In general, but not always, second contact will be later than predicted, and third contact earlier. If the solar limb relative to the lunar limb were to be plotted using the same exaggerated radial scale as the lunar limb (approximately 70 to 1), it would form an epicyclic curve separating from the lunar limb rapidly with position angle away from the predicted contact point. Furthermore, the movement of this epicyclic curve representing the solar limb, as a function of time in small intervals, is essentially along the radial direction from the mean limb at the contact point. When this epicyclic curve is shifted radially so as to be tangent to the true irregular limb, the displacement in seconds of arc is ascertained. The locus of such displacements for all position angles is a curve representing the displacement of the solar limb from the mean lunar limb at the true time it contacts the true lunar limb at any given position angle of contact.

To use this displacement curve to correct predicted contact times, it is necessary to relate the displacement in seconds of arc to a time interval. This is most conveniently achieved by plotting along with ' displacement curve already described another curve representing the location of the solar limb at each position angle at some specified constant time interval (e.g. 10 seconds) from the mean-limb contact time. The ratio of the displacement of the solar limb at true contact to the displacement in a constant time interval then gives directly the correction to be applied to account for the effect of the lunar limb features.

The first curve, for displacement from predicted contact, is nearly the same for the entire eclipse track, but the curve for displacement of the solar limb in 10 seconds is location-dependent and should be calculated for each major observing region in the path.

Overleaf is a pair of correction diagrams for Bangka Island, or the Sumatra area; facing that, the diagrams for Mindanao. Each pair is oriented to match the limb profile diagram, so that north is up and east is left. Conceptually, time flows left to right. The left-hand one of each pair is for second contact, the right-hand one is for third contact. The vertical line in each instance represents the instant of the mean, smooth limb, predicted contact. The smooth curved lines represent the relative displacement of the solar limb in 10 seconds. Position angles are marked on the vertical. The irregular curves running vertically represent the displacement at the instant of contact with the true, irregular limb.

To get the correction for a specific location, first obtain the predicted times and position angles of the second and third contacts, either from the tables or by estimation as described elsewhere. Choose the appropriate pair of diagrams. On the vertical lines, find each position angle and lay a ruler from that point to the associated point on the smooth solar limb displacement curve. Measure the distance between those two points, and the distance from the vertical line to the irregular displacement curve. Divide the second measure by the first and multiply by 10 to get the correction in seconds of time. For second contact, if the two curve points are on the same side of the vertical line, add the correction to the predicted time; otherwise subtract. For third contact, if the two curve points are on the same side of the vertical line, subtract the correction from the predicted contact time; otherwise add it.

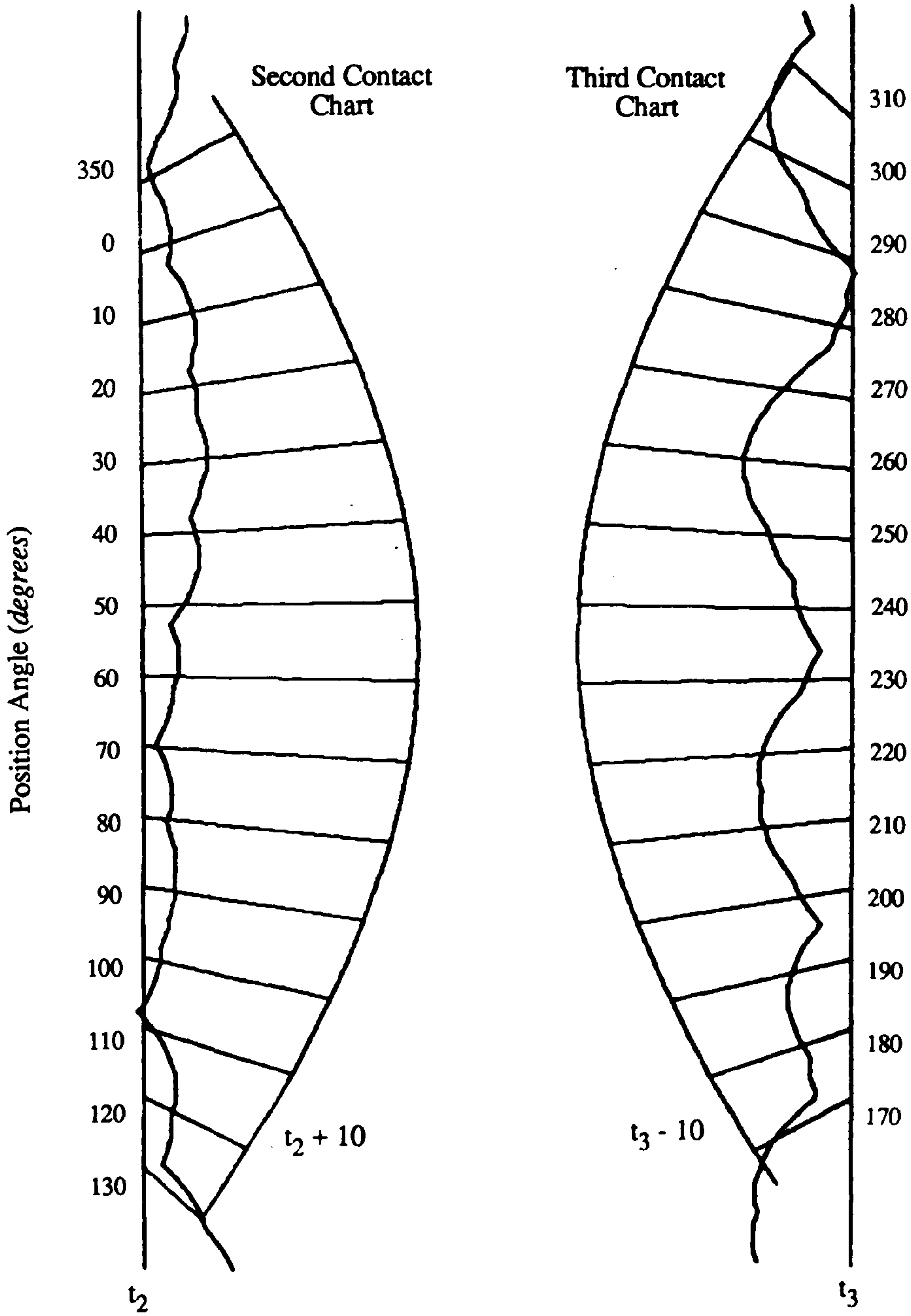
During the time interval of the correction, Baily's Bead effects may appear.

EXAMPLE: At Buayan (General Santos), from the table, the position angles are 54 and 222 degrees for the contacts. On the charts for Mindanao, on the left, for angle 54, the displacement curve lies about 5/33 of the distance to the solar limb curve, on the same side, hence the time correction is +1.5s. Similarly, on the right, for angle 222, the ratio of distances is approximately 12/33, on the same side of the vertical, hence the time correction is −3.6s. Applying these corrections to the predicted times gives 01h 03m 27.6s U.T. for second contact, 01h 06m 44.9s U.T. for third contact.

EXAMPLE: At Perambumulih, Sumatra, the position angles are 122 and 171 degrees. From the charts for Sumatra, the left-hand part gives a distance ratio of 5/15, hence a correction of +3.3s; the right-hand part gives 11/16 and −6.9s; hence the corrected contact times are 0h 29m 16.0s and 0h 30m 4.1sU.T., duration of totality being reduced 10.2s. However, a prolonged display of Baily's Beads would be expected.

LUNAR PROFILE CORRECTION DIAGRAMS

Bangka Island (Sumatra), Indonesia



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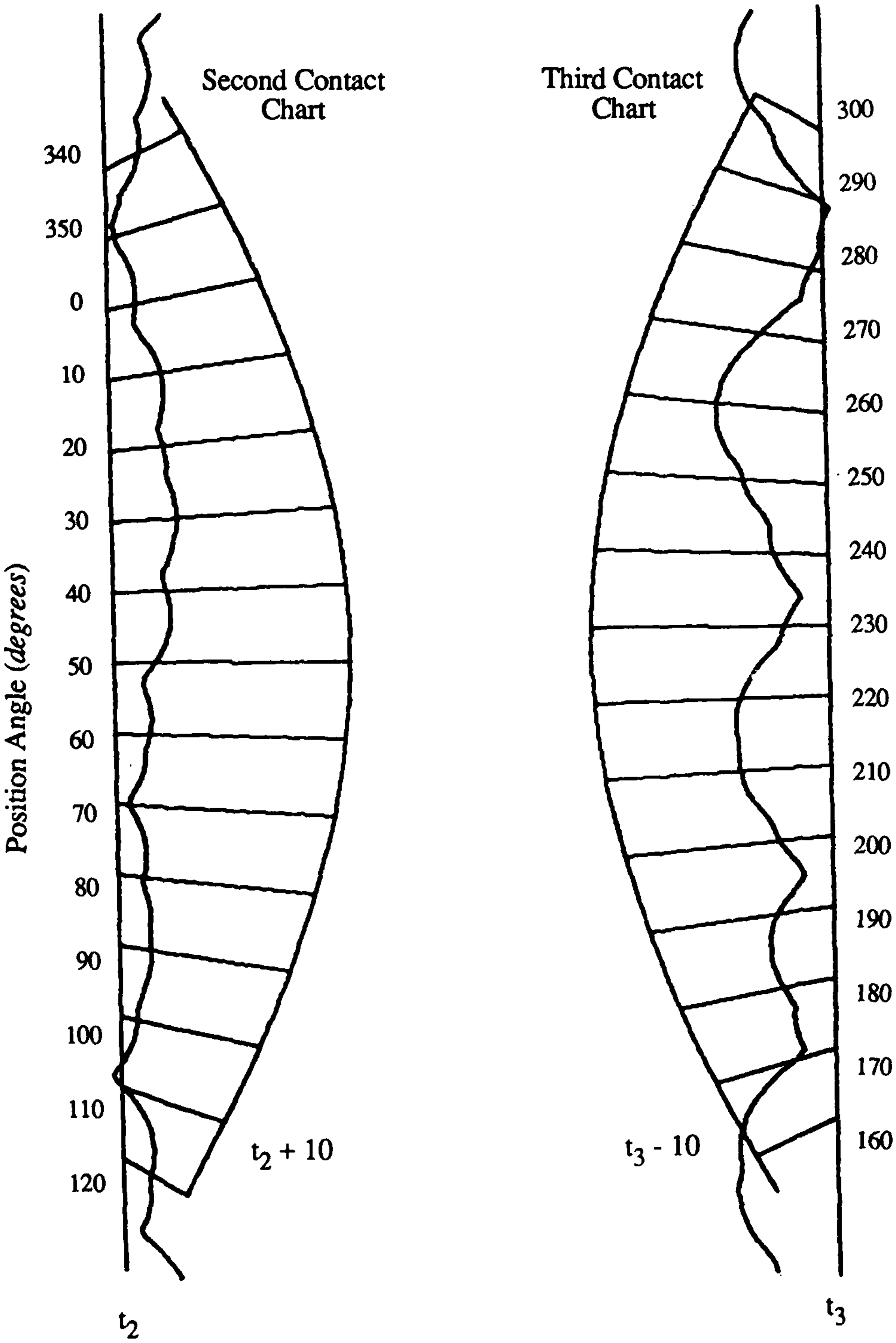
LUNAR PROFILE CORRECTION DIAGRAMS

Mindanao, Philippines



David Herald

SURFACE PATH OF THE TOTAL PHASE OVER LAND

Longitude	Latitude of Northern Limit	Latitude of Central Line	Latitude of Southern Limit	Universal Time at Northern Limit	Universal Time at Central Line	Universal Time at Southern Limit	On Central Line Maximum Duration	On Central Line Path Width	On Central Line Sun's Alt.	On Central Line Sun's Az.
° '	° '	° '	° '	h m s	h m s	h m s	m s	km	°	°
+ 99 00.0	- 3 05.7	- 3 42.5	- 4 19.0	0 27 21.7	0 26 46.2	0 26 12.1	2 08.8	134	14	90
+ 99 30.0	- 3 01.5	- 3 38.6	- 4 15.4	0 27 38.9	0 27 02.8	0 26 28.0	2 09.9	135	14	90
+100 00.0	- 2 57.1	- 3 34.5	- 4 11.5	0 27 56.9	0 27 20.1	0 26 44.7	2 11.1	136	15	90
+100 30.0	- 2 52.5	- 3 30.1	- 4 07.4	0 28 15.7	0 27 38.2	0 27 02.1	2 12.2	137	15	90
+101 00.0	- 2 47.7	- 3 25.6	- 4 03.1	0 28 35.3	0 27 57.1	0 27 20.4	2 13.4	137	16	90
+101 30.0	- 2 42.6	- 3 20.8	- 3 58.6	0 28 55.7	0 28 16.8	0 27 39.4	2 14.6	138	17	90
+102 00.0	- 2 37.4	- 3 15.8	- 3 53.9	0 29 17.0	0 28 37.3	0 27 59.2	2 15.8	139	17	90
+102 30.0	- 2 31.9	- 3 10.6	- 3 49.0	0 29 39.1	0 28 58.7	0 28 19.8	2 17.0	140	18	90
+103 00.0	- 2 26.2	- 3 05.2	- 3 43.8	0 30 02.1	0 29 20.9	0 28 41.3	2 18.3	141	18	90
+103 30.0	- 2 20.2	- 2 59.5	- 3 38.4	0 30 26.0	0 29 44.0	0 29 03.6	2 19.5	142	19	90
+104 00.0	- 2 14.0	- 2 53.6	- 3 32.8	0 30 50.8	0 30 07.9	0 29 26.7	2 20.8	142	20	90
+104 30.0	- 2 07.5	- 2 47.4	- 3 26.9	0 31 16.5	0 30 32.8	0 29 50.8	2 22.0	143	20	90
+105 00.0	- 2 00.8	- 2 41.0	- 3 20.8	0 31 43.2	0 30 58.6	0 30 15.7	2 23.3	144	21	90
+105 30.0	- 1 53.9	- 2 34.4	- 3 14.5	0 32 10.8	0 31 25.3	0 30 41.6	2 24.6	145	21	90
+106 00.0	- 1 46.7	- 2 27.5	- 3 07.9	0 32 39.4	0 31 53.0	0 31 08.3	2 25.9	146	22	90
+106 30.0	- 1 39.2	- 2 20.3	- 3 01.1	0 33 09.0	0 32 21.6	0 31 36.0	2 27.2	147	23	90
+107 00.0	- 1 31.4	- 2 12.9	- 2 54.0	0 33 39.6	0 32 51.2	0 32 04.7	2 28.6	148	23	90
+107 30.0	- 1 23.4	- 2 05.2	- 2 46.6	0 34 11.2	0 33 21.9	0 32 34.4	2 29.9	148	24	90
+108 00.0	- 1 15.1	- 1 57.3	- 2 39.0	0 34 43.9	0 33 53.5	0 33 05.0	2 31.3	149	24	90
+108 30.0	- 1 06.5	- 1 49.0	- 2 31.1	0 35 17.7	0 34 26.2	0 33 36.7	2 32.6	150	25	90
+109 00.0	- 0 57.6	- 1 40.5	- 2 22.9	0 35 52.5	0 34 59.9	0 34 09.4	2 34.0	151	26	90
+109 30.0	- 0 48.4	- 1 31.7	- 2 14.4	0 36 28.5	0 35 34.8	0 34 43.1	2 35.4	152	26	90
+110 00.0	- 0 38.9	- 1 22.5	- 2 05.7	0 37 05.6	0 36 10.7	0 35 17.9	2 36.8	153	27	90
+110 30.0	- 0 29.1	- 1 13.1	- 1 56.6	0 37 43.9	0 36 47.8	0 35 53.8	2 38.2	154	28	90
+111 00.0	- 0 19.0	- 1 03.4	- 1 47.2	0 38 23.3	0 37 26.0	0 36 30.9	2 39.7	155	28	90
+111 30.0	- 0 08.6	- 0 53.3	- 1 37.6	0 39 04.0	0 38 05.4	0 37 09.0	2 41.1	155	29	91
+112 00.0	+ 0 02.2	- 0 43.0	- 1 27.6	0 39 45.9	0 38 46.0	0 37 48.4	2 42.6	156	30	91
+112 30.0	+ 0 13.3	- 0 32.3	- 1 17.3	0 40 29.0	0 39 27.8	0 38 28.9	2 44.0	157	30	91
+113 00.0	+ 0 24.8	- 0 21.2	- 1 06.7	0 41 13.5	0 40 10.9	0 39 10.6	2 45.5	158	31	91
+113 30.0	+ 0 36.6	- 0 09.9	- 0 55.7	0 41 59.2	0 40 55.2	0 39 53.6	2 47.0	159	32	91
+114 00.0	+ 0 48.7	+ 0 01.9	- 0 44.4	0 42 46.3	0 41 40.8	0 40 37.8	2 48.5	160	32	91
+114 30.0	+ 1 01.3	+ 0 13.9	- 0 32.7	0 43 34.7	0 42 27.8	0 41 23.3	2 50.0	160	33	91
+115 00.0	+ 1 14.2	+ 0 26.4	- 0 20.7	0 44 24.5	0 43 16.1	0 42 10.2	2 51.5	161	34	91
+115 30.0	+ 1 27.4	+ 0 39.2	- 0 08.4	0 45 15.8	0 44 05.7	0 42 58.3	2 53.1	162	34	92
+116 00.0	+ 1 41.1	+ 0 52.4	+ 0 04.4	0 46 08.4	0 44 56.8	0 43 47.8	2 54.6	163	35	92
+116 30.0	+ 1 55.2	+ 1 06.0	+ 0 17.5	0 47 02.6	0 45 49.3	0 44 38.8	2 56.1	164	36	92
+117 00.0	+ 2 09.7	+ 1 20.0	+ 0 31.0	0 47 58.3	0 46 43.3	0 45 31.1	2 57.7	165	37	92
+117 30.0	+ 2 24.6	+ 1 34.4	+ 0 44.9	0 48 55.4	0 47 38.7	0 46 24.9	2 59.3	165	37	92
+118 00.0	+ 2 39.9	+ 1 49.2	+ 0 59.2	0 49 54.2	0 48 35.7	0 47 20.1	3 00.8	166	38	93
+118 30.0	+ 2 55.6	+ 2 04.4	+ 1 13.9	0 50 54.5	0 49 34.2	0 48 16.9	3 02.4	167	39	93
+119 00.0	+ 3 11.8	+ 2 20.1	+ 1 29.1	0 51 56.5	0 50 34.3	0 49 15.2	3 04.0	168	40	93
+119 30.0	+ 3 28.5	+ 2 36.2	+ 1 44.6	0 53 00.1	0 51 36.0	0 50 15.0	3 05.6	168	40	93
+120 00.0	+ 3 45.6	+ 2 52.7	+ 2 00.6	0 54 05.3	0 52 39.4	0 51 16.5	3 07.2	169	41	94
+120 30.0	+ 4 03.1	+ 3 09.7	+ 2 17.1	0 55 12.3	0 53 44.4	0 52 19.6	3 08.8	170	42	94
+121 00.0	+ 4 21.2	+ 3 27.2	+ 2 34.0	0 56 21.0	0 54 51.1	0 53 24.3	3 10.3	170	42	94
+121 30.0	+ 4 39.7	+ 3 45.1	+ 2 51.3	0 57 31.5	0 55 59.5	0 54 30.7	3 11.9	171	43	95
+122 00.0	+ 4 58.7	+ 4 03.5	+ 3 09.2	0 58 43.8	0 57 09.6	0 55 38.8	3 13.5	172	44	95
+122 30.0	+ 5 18.3	+ 4 22.4	+ 3 27.5	0 59 57.8	0 58 21.6	0 56 48.7	3 15.1	172	45	96
+123 00.0	+ 5 38.3	+ 4 41.9	+ 3 46.3	1 01 13.7	0 59 35.3	0 58 00.3	3 16.7	173	46	96
+123 30.0	+ 5 58.8	+ 5 01.8	+ 4 05.6	1 02 31.5	1 00 50.9	0 59 13.7	3 18.3	173	46	97
+124 00.0	+ 6 19.9	+ 5 22.2	+ 4 25.4	1 03 51.1	1 02 08.3	1 00 28.9	3 19.8	174	47	97
+124 30.0	+ 6 41.5	+ 5 43.2	+ 4 45.8	1 05 12.7	1 03 27.6	1 01 46.0	3 21.4	174	48	98
+125 00.0	+ 7 03.7	+ 6 04.7	+ 5 06.6	1 06 36.1	1 04 48.8	1 03 04.9	3 22.9	175	49	98
+125 30.0	+ 7 26.4	+ 6 26.7	+ 5 28.0	1 08 01.5	1 06 11.9	1 04 25.8	3 24.5	175	49	99
+126 00.0	+ 7 49.6	+ 6 49.3	+ 5 49.9	1 09 28.8	1 07 36.9	1 05 48.5	3 26.0	175	50	100
+126 30.0	+ 8 13.5	+ 7 12.4	+ 6 12.4	1 10 58.0	1 09 03.8	1 07 13.1	3 27.5	176	51	100
+127 00.0	+ 8 37.8	+ 7 36.1	+ 6 35.4	1 12 29.1	1 10 32.6	1 08 39.7	3 28.9	176	52	101
+127 30.0	+ 9 02.7	+ 8 00.3	+ 6 59.0	1 14 02.2	1 12 03.4	1 10 08.1	3 30.4	176	53	102
+128 00.0	+ 9 28.2	+ 8 25.2	+ 7 23.1	1 15 37.2	1 13 36.1	1 11 38.6	3 31.8	177	53	103
+128 30.0	+ 9 54.3	+ 8 50.5	+ 7 47.8	1 17 14.1	1 15 10.8	1 13 10.9	3 33.2	177	54	104
+129 00.0	+10 20.9	+ 9 16.4	+ 8 13.0	1 18 52.9	1 16 47.3	1 14 45.2	3 34.6	177	55	105
+129 30.0	+10 48.0	+ 9 42.9	+ 8 38.8	1 20 33.5	1 18 25.8	1 16 21.4	3 35.9	177	56	106
+130 00.0	+11 15.8	+10 10.0	+ 9 05.2	1 22 15.9	1 20 06.1	1 17 59.5	3 37.2	177	56	107

To correct for elevation above sea level, please see table of corrections, page 31.

CORRECTIONS FOR ELEVATION ABOVE SEA LEVEL

Longitude	Latitude	U.T.
° '	"	s
+ 99 00.0	-5.204	-0.364
+ 99 30.0	-5.242	-0.366
+100 00.0	-5.275	-0.367
+100 30.0	-5.311	-0.368
+101 00.0	-5.347	-0.370
+101 30.0	-5.382	-0.371
+102 00.0	-5.420	-0.372
+102 30.0	-5.458	-0.374
+103 00.0	-5.495	-0.375
+103 30.0	-5.534	-0.376
+104 00.0	-5.573	-0.378
+104 30.0	-5.613	-0.379
+105 00.0	-5.653	-0.380
+105 30.0	-5.694	-0.381
+106 00.0	-5.735	-0.383
+106 30.0	-5.777	-0.384
+107 00.0	-5.819	-0.385
+107 30.0	-5.862	-0.386
+108 00.0	-5.905	-0.388
+108 30.0	-5.949	-0.389
+109 00.0	-5.993	-0.390
+109 30.0	-6.038	-0.391
+110 00.0	-6.084	-0.392
+110 30.0	-6.130	-0.393
+111 00.0	-6.176	-0.394
+111 30.0	-6.223	-0.395
+112 00.0	-6.270	-0.396
+112 30.0	-6.318	-0.397
+113 00.0	-6.366	-0.398
+113 30.0	-6.415	-0.399
+114 00.0	-6.464	-0.400
+114 30.0	-6.513	-0.400
+115 00.0	-6.562	-0.401
+115 30.0	-6.612	-0.402
+116 00.0	-6.662	-0.402
+116 30.0	-6.712	-0.403
+117 00.0	-6.763	-0.403
+117 30.0	-6.813	-0.404
+118 00.0	-6.864	-0.404
+118 30.0	-6.914	-0.404
+119 00.0	-6.964	-0.404
+119 30.0	-7.014	-0.404
+120 00.0	-7.064	-0.404
+120 30.0	-7.113	-0.404
+121 00.0	-7.162	-0.403
+121 30.0	-7.210	-0.403
+122 00.0	-7.258	-0.402
+122 30.0	-7.304	-0.401
+123 00.0	-7.350	-0.400
+123 30.0	-7.394	-0.399

Longitude	Latitude	U.T.
° '	"	s
+124 00.0	-7.437	-0.398
+124 30.0	-7.478	-0.396
+125 00.0	-7.518	-0.394
+125 30.0	-7.556	-0.392
+126 00.0	-7.591	-0.390
+126 30.0	-7.624	-0.387
+127 00.0	-7.654	-0.384
+127 30.0	-7.682	-0.381
+128 00.0	-7.706	-0.377
+128 30.0	-7.726	-0.373
+129 00.0	-7.743	-0.369
+129 30.0	-7.756	-0.364
+130 00.0	-7.765	-0.359

These corrections to latitude and time are to be applied to the data on page 30 to correct for elevation. This table was constructed by differencing the data displayed on page 32. The units are seconds of arc or seconds of time per thousand feet.

Example: Elevation 1500 ft. at longitude 104 degrees.

Lat. corr.: $-5''.573 \times 1.5 = -8''.36 = -0'.1$

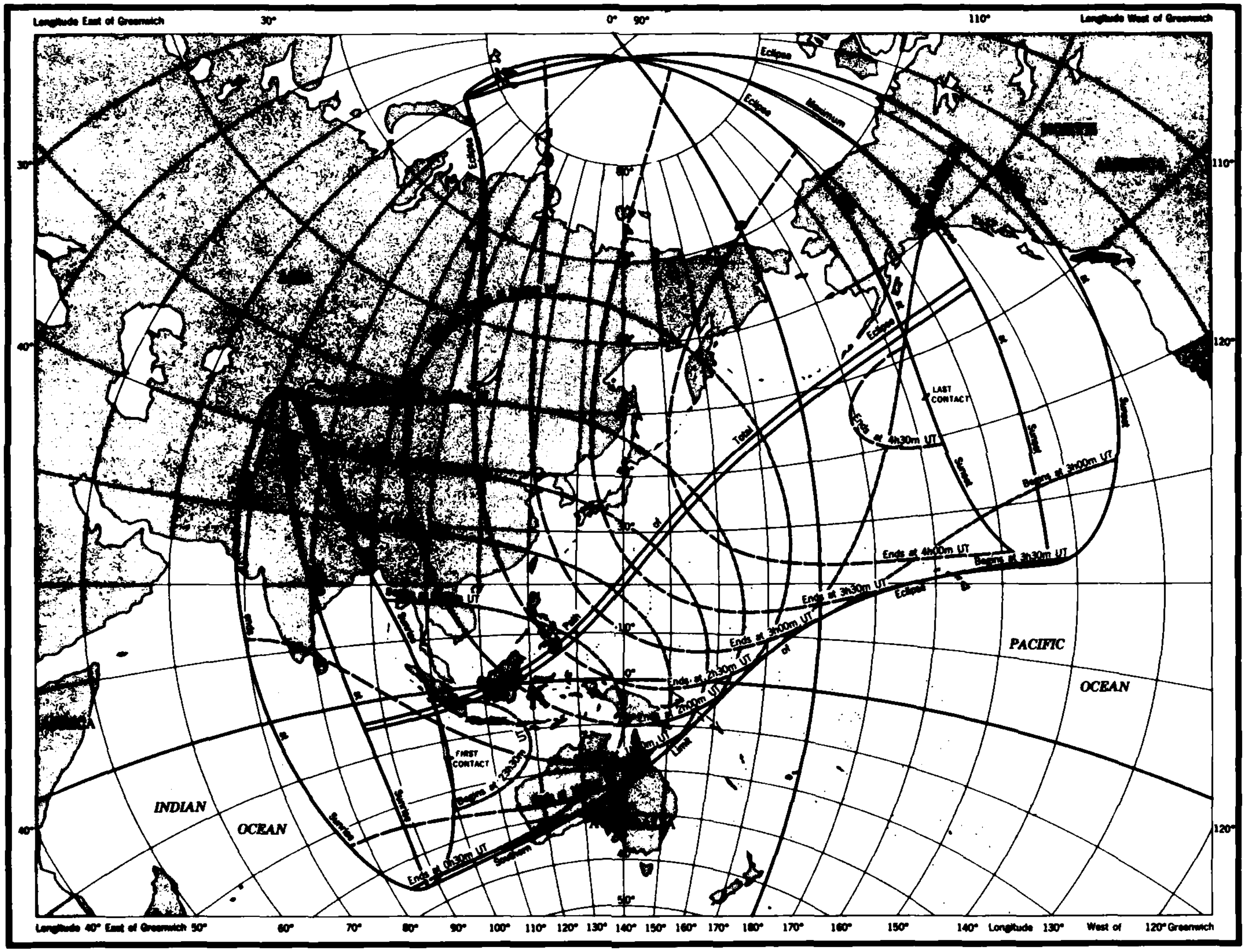
Time corr.: $-0^s.378 \times 1.5 = -0^s.6$

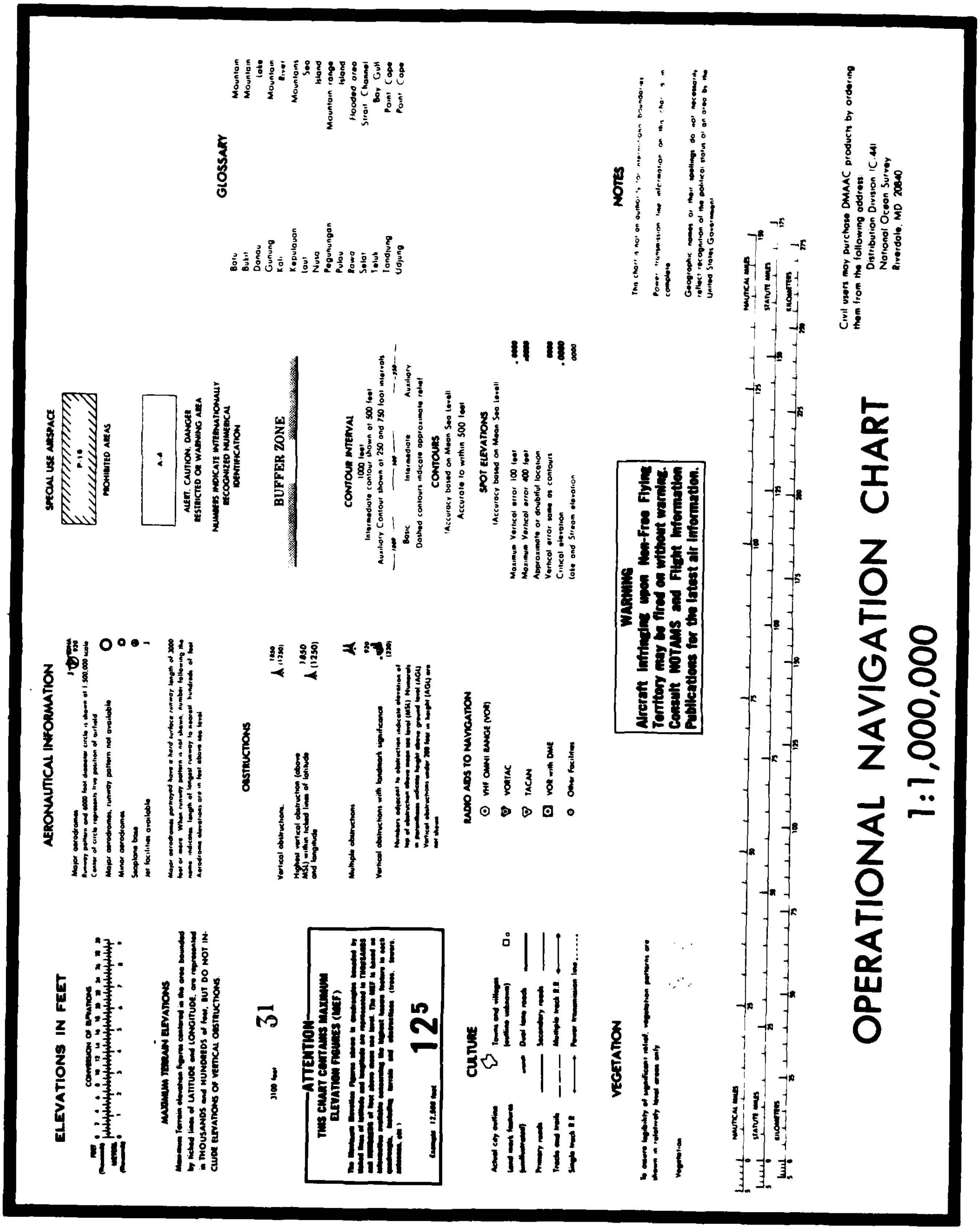
Hence for the eleventh tabular entry on page 30, the three latitude entries should be shifted south by 0'.1, and the three times advanced (made earlier) by $0^s.6$.

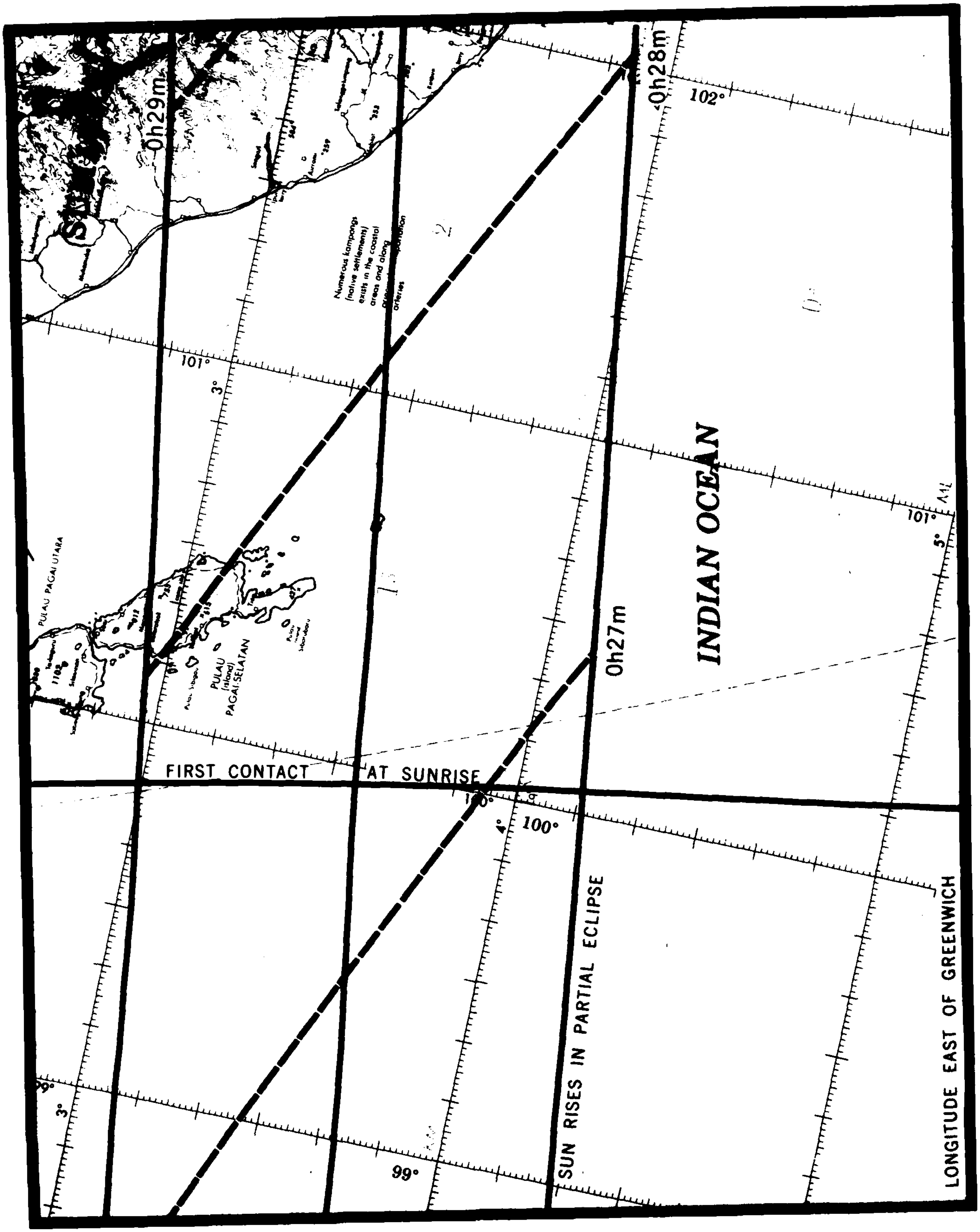
PATH OF THE TOTAL PHASE OVER LAND AT FLYING ALTITUDES

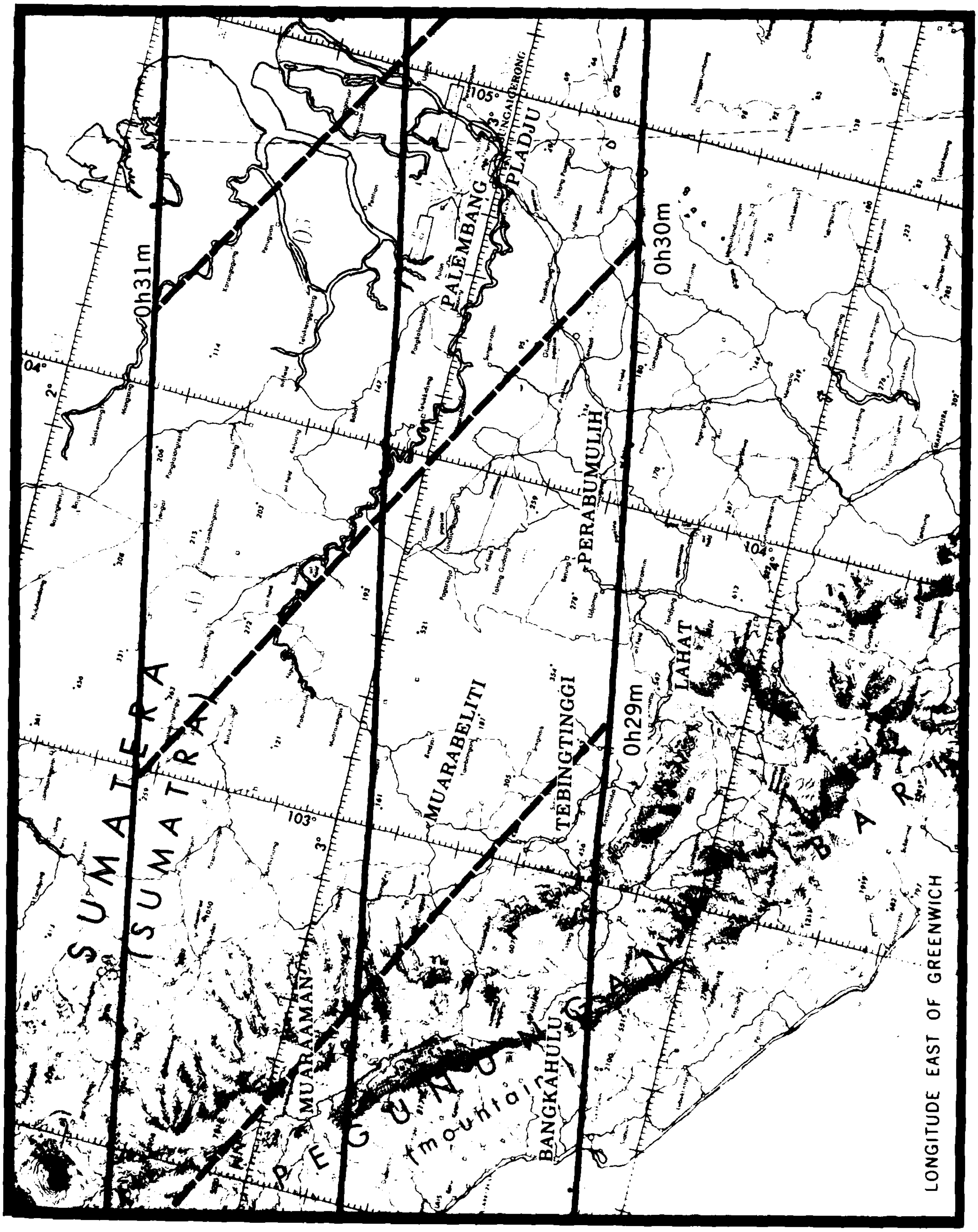
Longitude	Latitude of Northern Limit at			Latitude of Central Line at			Latitude of Southern Limit at		
	Sea Level	10000 Ft.	40000 Ft.	Sea Level	10000 Ft.	40000 Ft.	Sea Level	10000 Ft.	40000 Ft.
° '	° '	° '	° '	° '	° '	° '	° '	° '	° '
+ 99 00.0	- 3 05.7	- 3 06.6	- 3 09.2	- 3 42.5	- 3 43.4	- 3 46.0	- 4 19.0	- 4 19.9	- 4 22.4
+ 99 30.0	- 3 01.5	- 3 02.4	- 3 05.1	- 3 38.6	- 3 39.5	- 3 42.1	- 4 15.4	- 4 16.2	- 4 18.8
+100 00.0	- 2 57.1	- 2 58.0	- 3 00.7	- 3 34.5	- 3 35.3	- 3 38.0	- 4 11.5	- 4 12.3	- 4 14.9
+100 30.0	- 2 52.5	- 2 53.4	- 2 56.1	- 3 30.1	- 3 31.0	- 3 33.7	- 4 07.4	- 4 08.3	- 4 10.8
+101 00.0	- 2 47.7	- 2 48.6	- 2 51.4	- 3 25.6	- 3 26.5	- 3 29.1	- 4 03.1	- 4 04.0	- 4 06.6
+101 30.0	- 2 42.6	- 2 43.6	- 2 46.3	- 3 20.8	- 3 21.7	- 3 24.4	- 3 58.6	- 3 59.5	- 4 02.1
+102 00.0	- 2 37.4	- 2 38.3	- 2 41.1	- 3 15.8	- 3 16.7	- 3 19.4	- 3 53.9	- 3 54.8	- 3 57.4
+102 30.0	- 2 31.9	- 2 32.8	- 2 35.6	- 3 10.6	- 3 11.5	- 3 14.2	- 3 49.0	- 3 49.9	- 3 52.5
+103 00.0	- 2 26.2	- 2 27.1	- 2 29.9	- 3 05.2	- 3 06.1	- 3 08.8	- 3 43.8	- 3 44.7	- 3 47.4
+103 30.0	- 2 20.2	- 2 21.2	- 2 24.0	- 2 59.5	- 3 00.4	- 3 03.2	- 3 38.4	- 3 39.3	- 3 42.0
+104 00.0	- 2 14.0	- 2 15.0	- 2 17.8	- 2 53.6	- 2 54.5	- 2 57.3	- 3 32.8	- 3 33.7	- 3 36.4
+104 30.0	- 2 07.5	- 2 08.5	- 2 11.4	- 2 47.4	- 2 48.4	- 2 51.2	- 3 26.9	- 3 27.9	- 3 30.6
+105 00.0	- 2 00.8	- 2 01.8	- 2 04.7	- 2 41.0	- 2 42.0	- 2 44.8	- 3 20.8	- 3 21.8	- 3 24.5
+105 30.0	- 1 53.9	- 1 54.9	- 1 57.8	- 2 34.4	- 2 35.3	- 2 38.2	- 3 14.5	- 3 15.4	- 3 18.2
+106 00.0	- 1 46.7	- 1 47.7	- 1 50.6	- 2 27.5	- 2 28.5	- 2 31.3	- 3 07.9	- 3 08.8	- 3 11.6
+106 30.0	- 1 39.2	- 1 40.2	- 1 43.2	- 2 20.3	- 2 21.3	- 2 24.2	- 3 01.1	- 3 02.0	- 3 04.8
+107 00.0	- 1 31.4	- 1 32.4	- 1 35.4	- 2 12.9	- 2 13.9	- 2 16.8	- 2 54.0	- 2 54.9	- 2 57.7
+107 30.0	- 1 23.4	- 1 24.4	- 1 27.4	- 2 05.2	- 2 06.2	- 2 09.1	- 2 46.6	- 2 47.6	- 2 50.4
+108 00.0	- 1 15.1	- 1 16.1	- 1 19.2	- 1 57.3	- 1 58.2	- 2 01.2	- 2 39.0	- 2 39.9	- 2 42.8
+108 30.0	- 1 06.5	- 1 07.5	- 1 10.6	- 1 49.0	- 1 50.0	- 1 53.0	- 2 31.1	- 2 32.0	- 2 34.9
+109 00.0	- 0 57.6	- 0 58.6	- 1 01.7	- 1 40.5	- 1 41.5	- 1 44.5	- 2 22.9	- 2 23.9	- 2 26.8
+109 30.0	- 0 48.4	- 0 49.5	- 0 52.6	- 1 31.7	- 1 32.7	- 1 35.7	- 2 14.4	- 2 15.4	- 2 18.3
+110 00.0	- 0 38.9	- 0 40.0	- 0 43.1	- 1 22.5	- 1 23.6	- 1 26.6	- 2 05.7	- 2 06.6	- 2 09.6
+110 30.0	- 0 29.1	- 0 30.2	- 0 33.3	- 1 13.1	- 1 14.1	- 1 17.2	- 1 56.6	- 1 57.6	- 2 00.6
+111 00.0	- 0 19.0	- 0 20.1	- 0 23.3	- 1 03.4	- 1 04.4	- 1 07.5	- 1 47.2	- 1 48.2	- 1 51.2
+111 30.0	- 0 08.6	- 0 09.6	- 0 12.8	- 0 53.3	- 0 54.4	- 0 57.5	- 1 37.6	- 1 38.6	- 1 41.6
+112 00.0	+ 0 02.2	+ 0 01.1	- 0 02.1	- 0 43.0	- 0 44.0	- 0 47.2	- 1 27.6	- 1 28.6	- 1 31.7
+112 30.0	+ 0 13.3	+ 0 12.2	+ 0 09.0	- 0 32.3	- 0 33.3	- 0 36.5	- 1 17.3	- 1 18.3	- 1 21.4
+113 00.0	+ 0 24.8	+ 0 23.7	+ 0 20.4	- 0 21.2	- 0 22.3	- 0 25.5	- 1 06.7	- 1 07.7	- 1 10.8
+113 30.0	+ 0 36.6	+ 0 35.5	+ 0 32.2	- 0 09.9	- 0 10.9	- 0 14.1	- 0 55.7	- 0 56.7	- 0 59.9
+114 00.0	+ 0 48.7	+ 0 47.6	+ 0 44.3	+ 0 01.9	+ 0 00.8	- 0 02.4	- 0 44.4	- 0 45.4	- 0 48.6
+114 30.0	+ 1 01.3	+ 1 00.1	+ 0 56.8	+ 0 13.9	+ 0 12.9	+ 0 09.6	- 0 32.7	- 0 33.8	- 0 37.0
+115 00.0	+ 1 14.2	+ 1 13.0	+ 1 09.7	+ 0 26.4	+ 0 25.3	+ 0 22.0	- 0 20.7	- 0 21.8	- 0 25.0
+115 30.0	+ 1 27.4	+ 1 26.3	+ 1 22.9	+ 0 39.2	+ 0 38.1	+ 0 34.8	- 0 08.4	- 0 09.4	- 0 12.7
+116 00.0	+ 1 41.1	+ 1 40.0	+ 1 36.5	+ 0 52.4	+ 0 51.3	+ 0 48.0	+ 0 04.4	+ 0 03.3	+ 0 00.1
+116 30.0	+ 1 55.2	+ 1 54.0	+ 1 50.6	+ 1 06.0	+ 1 04.9	+ 1 01.5	+ 0 17.5	+ 0 16.4	+ 0 13.1
+117 00.0	+ 2 09.7	+ 2 08.5	+ 2 05.0	+ 1 20.0	+ 1 18.9	+ 1 15.5	+ 0 31.0	+ 0 29.9	+ 0 26.6
+117 30.0	+ 2 24.6	+ 2 23.4	+ 2 19.9	+ 1 34.4	+ 1 33.2	+ 1 29.8	+ 0 44.9	+ 0 43.8	+ 0 40.5
+118 00.0	+ 2 39.9	+ 2 38.7	+ 2 35.2	+ 1 49.2	+ 1 48.0	+ 1 44.6	+ 0 59.2	+ 0 58.1	+ 0 54.8
+118 30.0	+ 2 55.6	+ 2 54.4	+ 2 50.9	+ 2 04.4	+ 2 03.3	+ 1 59.8	+ 1 13.9	+ 1 12.8	+ 1 09.4
+119 00.0	+ 3 11.8	+ 3 10.6	+ 3 07.0	+ 2 20.1	+ 2 18.9	+ 2 15.4	+ 1 29.1	+ 1 27.9	+ 1 24.5
+119 30.0	+ 3 28.5	+ 3 27.3	+ 3 23.7	+ 2 36.2	+ 2 35.0	+ 2 31.5	+ 1 44.6	+ 1 43.5	+ 1 40.1
+120 00.0	+ 3 45.6	+ 3 44.4	+ 3 40.7	+ 2 52.7	+ 2 51.5	+ 2 48.0	+ 2 00.6	+ 1 59.5	+ 1 56.0
+120 30.0	+ 4 03.1	+ 4 01.9	+ 3 58.3	+ 3 09.7	+ 3 08.5	+ 3 05.0	+ 2 17.1	+ 2 15.9	+ 2 12.5
+121 00.0	+ 4 21.2	+ 4 19.9	+ 4 16.3	+ 3 27.2	+ 3 26.0	+ 3 22.4	+ 2 34.0	+ 2 32.8	+ 2 29.3
+121 30.0	+ 4 39.7	+ 4 38.5	+ 4 34.8	+ 3 45.1	+ 3 43.9	+ 3 40.3	+ 2 51.3	+ 2 50.2	+ 2 46.7
+122 00.0	+ 4 58.7	+ 4 57.5	+ 4 53.8	+ 4 03.5	+ 4 02.3	+ 3 58.7	+ 3 09.2	+ 3 08.0	+ 3 04.5
+122 30.0	+ 5 18.3	+ 5 17.0	+ 5 13.3	+ 4 22.4	+ 4 21.2	+ 4 17.6	+ 3 27.5	+ 3 26.3	+ 3 22.8
+123 00.0	+ 5 38.3	+ 5 37.0	+ 5 33.3	+ 4 41.9	+ 4 40.6	+ 4 37.0	+ 3 46.3	+ 3 45.1	+ 3 41.5
+123 30.0	+ 5 58.8	+ 5 57.6	+ 5 53.8	+ 5 01.8	+ 5 00.5	+ 4 56.8	+ 4 05.6	+ 4 04.4	+ 4 00.8
+124 00.0	+ 6 19.9	+ 6 18.7	+ 6 14.8	+ 5 22.2	+ 5 21.0	+ 5 17.3	+ 4 25.4	+ 4 24.2	+ 4 20.6
+124 30.0	+ 6 41.5	+ 6 40.3	+ 6 36.4	+ 5 43.2	+ 5 41.9	+ 5 38.2	+ 4 45.8	+ 4 44.5	+ 4 40.9
+125 00.0	+ 7 03.7	+ 7 02.4	+ 6 58.6	+ 6 04.7	+ 6 03.4	+ 5 59.7	+ 5 06.6	+ 5 05.4	+ 5 01.7
+125 30.0	+ 7 26.4	+ 7 25.1	+ 7 21.2	+ 6 26.7	+ 6 25.5	+ 6 21.7	+ 5 28.0	+ 5 26.8	+ 5 23.1
+126 00.0	+ 7 49.6	+ 7 48.4	+ 7 44.5	+ 6 49.3	+ 6 48.0	+ 6 44.2	+ 5 49.9	+ 5 48.7	+ 5 45.0
+126 30.0	+ 8 13.5	+ 8 12.2	+ 8 08.2	+ 7 12.4	+ 7 11.1	+ 7 07.3	+ 6 12.4	+ 6 11.1	+ 6 07.4
+127 00.0	+ 8 37.8	+ 8 36.5	+ 8 32.6	+ 7 36.1	+ 7 34.8	+ 7 31.0	+ 6 35.4	+ 6 34.1	+ 6 30.4
+127 30.0	+ 9 02.7	+ 9 01.4	+ 8 57.5	+ 8 00.3	+ 7 59.1	+ 7 55.2	+ 6 59.0	+ 6 57.7	+ 6 54.0
+128 00.0	+ 9 28.2	+ 9 26.9	+ 9 23.0	+ 8 25.2	+ 8 23.9	+ 8 20.0	+ 7 23.1	+ 7 21.8	+ 7 18.1
+128 30.0	+ 9 54.3	+ 9 53.0	+ 9 49.0	+ 8 50.5	+ 8 49.2	+ 8 45.4	+ 7 47.8	+ 7 46.5	+ 7 42.7
+129 00.0	+10 20.9	+10 19.6	+10 15.6	+ 9 16.4	+ 9 15.2	+ 9 11.3	+ 8 13.0	+ 8 11.8	+ 8 08.0
+129 30.0	+10 48.0	+10 46.7	+10 42.8	+ 9 42.9	+ 9 41.6	+ 9 37.8	+ 8 38.8	+ 8 37.6	+ 8 33.8
+130 00.0	+11 15.8	+11 14.4	+11 10.5	+10 10.0	+10 08.7	+10 04.8	+ 9 05.2	+ 9 03.9	+ 9 00.1

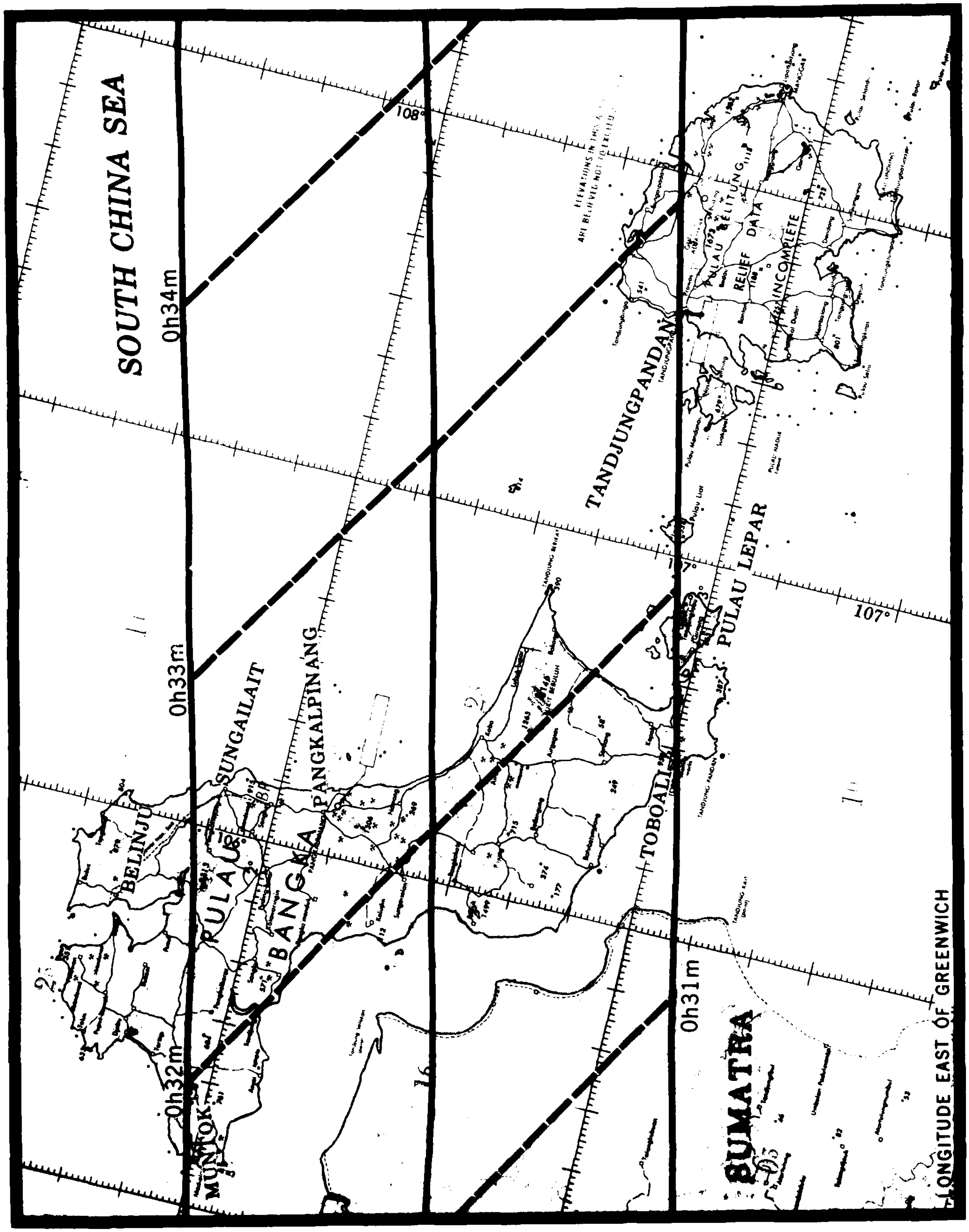
TOTAL SOLAR ECLIPSE OF 1988 MARCH 17-18

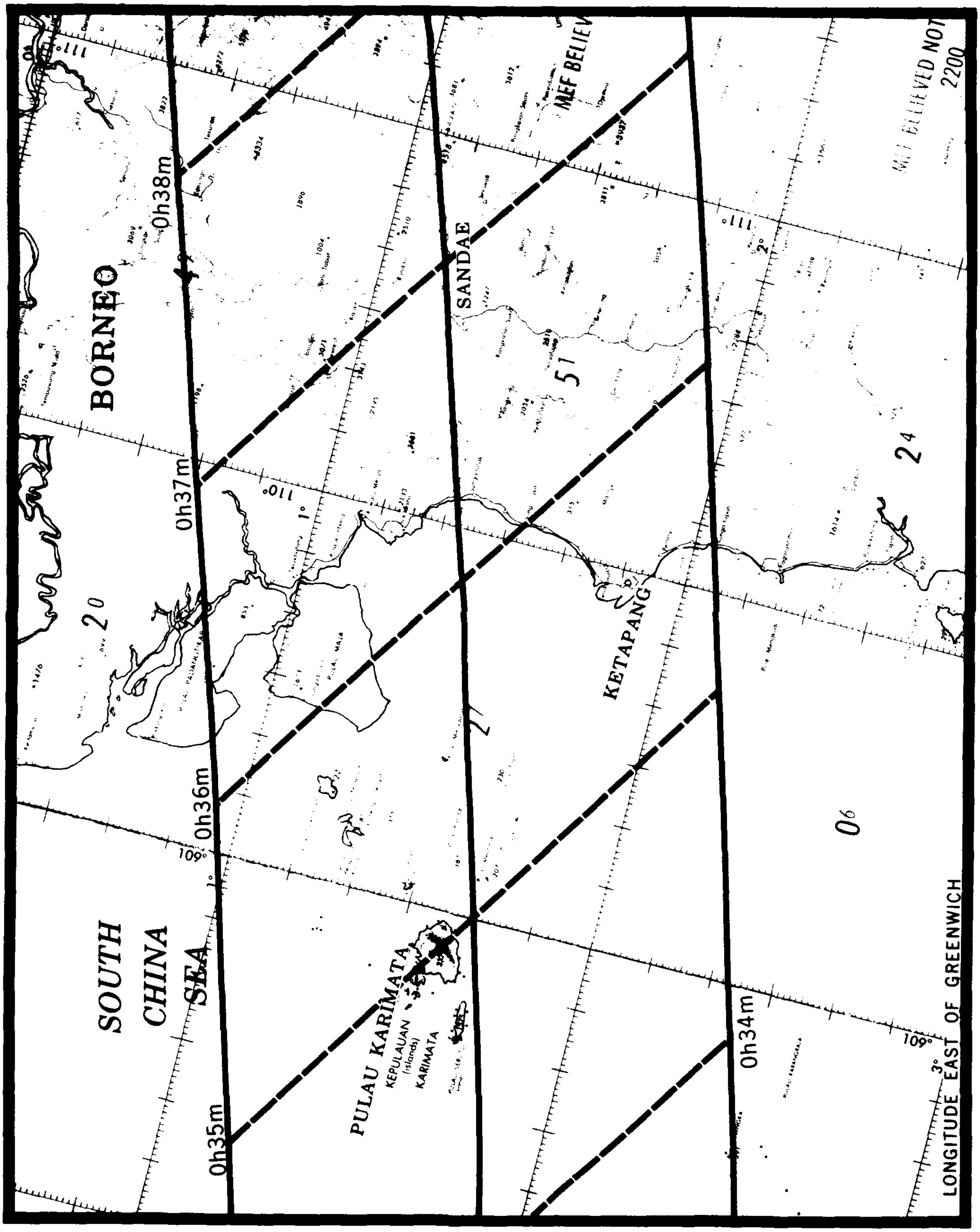


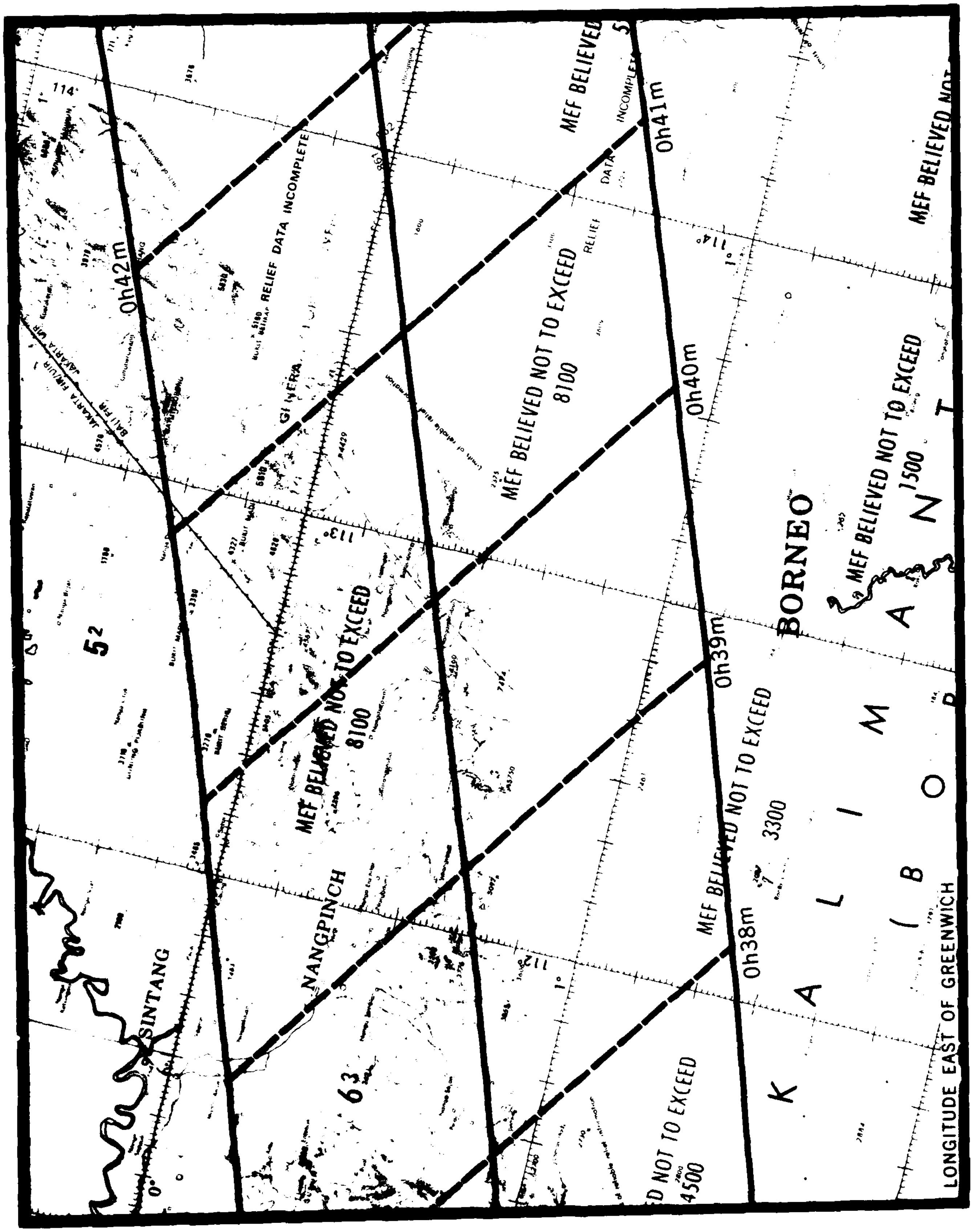

ELEVATIONS IN FEET
MAXIMUM TERRAIN ELEVATIONS
ATTENTION
THIS CHART CONTAINS MAXIMUM ELEVATION FIGURES (MEF)
31
125
CULTURE
VEGETATION
AERONAUTICAL INFORMATION
OBSTRUCTIONS
RADIO AIDS TO NAVIGATION
VHF OMNI RANGE (VOR)
VORTAC
TACAN
VOR with DME
Other Facilities
SPECIAL USE AIRSPACE
PROHIBITED AREAS
ALERT, CAUTION, DANGER RESTRICTED OR WARNING AREA
BUFFER ZONE
CONTOUR INTERVAL
1000 feet
Intermediate contour shown at 500 feet
Auxiliary Contour shown at 250 and 750 foot intervals
Basic
Intermediate
Auxiliary
Dashed contours indicate approximate relief
CONTOURS
(Accuracy based on Mean Sea Level)
Accurate to within 500 feet
SPOT ELEVATIONS
(Accuracy based on Mean Sea Level)
Maximum Vertical error 100 feet
Maximum Vertical error 400 feet
Approximate or doubtful location
Vertical error same as contours
Critical elevation
Lake and Stream elevation
WARNING
Aircraft infringing upon Non-Free Flying Territory may be fired on without warning. Consult NOTAMS and Flight Information Publications for the latest air information.
GLOSSARY
Batu Mountain
Bukit Mountain
Danau Lake
Gunung Mountain
Kali River
Kepulauan Mountains
Laut Sea
Nusa Island
Pegunungan Mountain range
Pulau Island
Rawa Flooded area
Selat Strait Channel
Teluk Bay Gulf
Tandjung Point Cape
Udjung Point Cape
NOTES
Geographic names or their spellings do not necessarily reflect recognition of the political status of an area by the United States Government.
Civil users may purchase DMAAC products by ordering them from the following address:
Distribution Division (C-44)
National Ocean Survey
Riverdale, MD 20840
NAUTICAL MILES
STATUTE MILES
KILOMETERS
OPERATIONAL NAVIGATION CHART
1:1,000,000

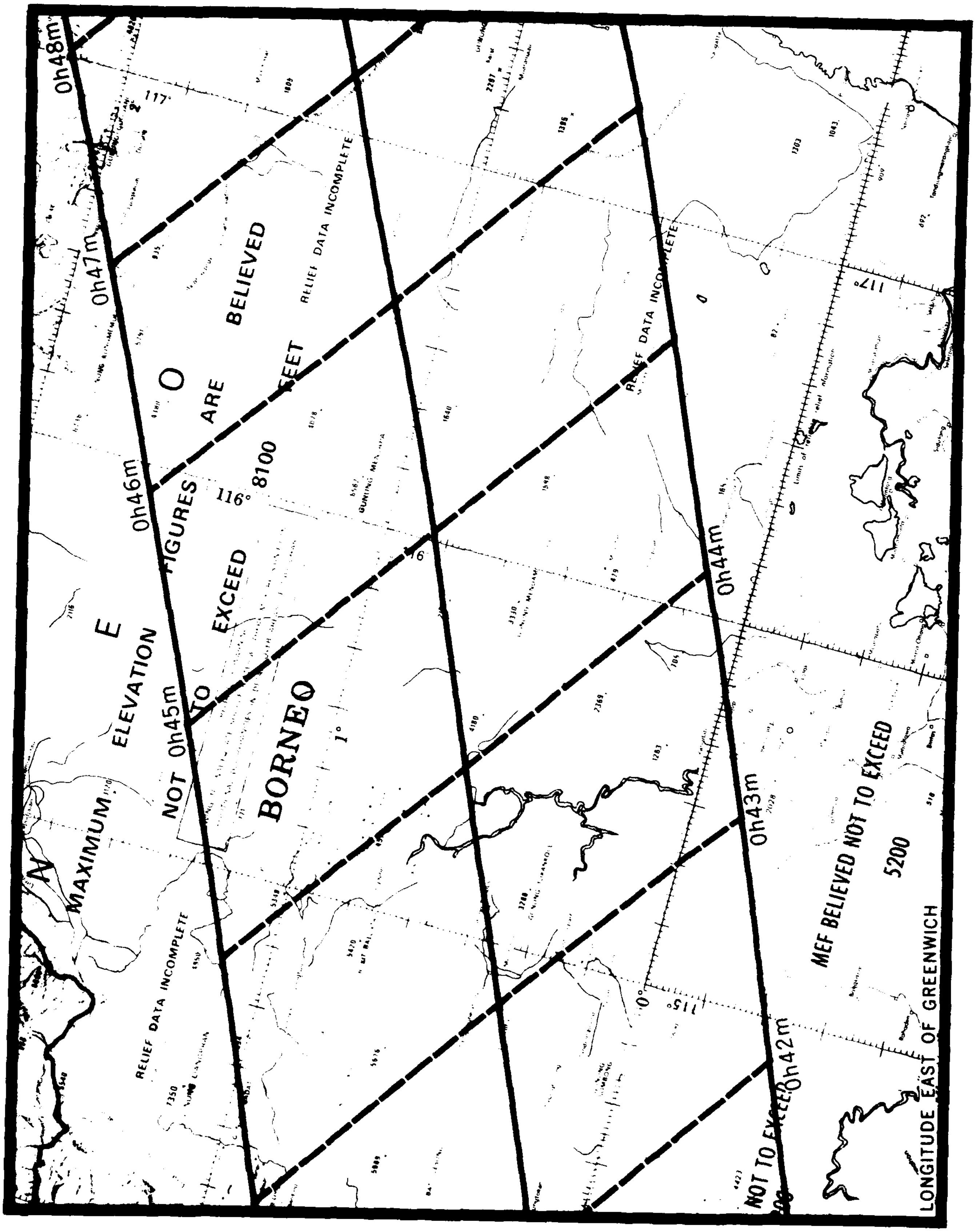

0h29m
0h28m
0h27m
102°
101°
3°
101°
5°
INDIAN OCEAN
PULAU PAGAI UTARA
PULAU (island) PAGAI SELATAN
FIRST CONTACT AT SUNRISE
100°
4°
100°
99°
3°
99°
SUN RISES IN PARTIAL ECLIPSE
LONGITUDE EAST OF GREENWICH

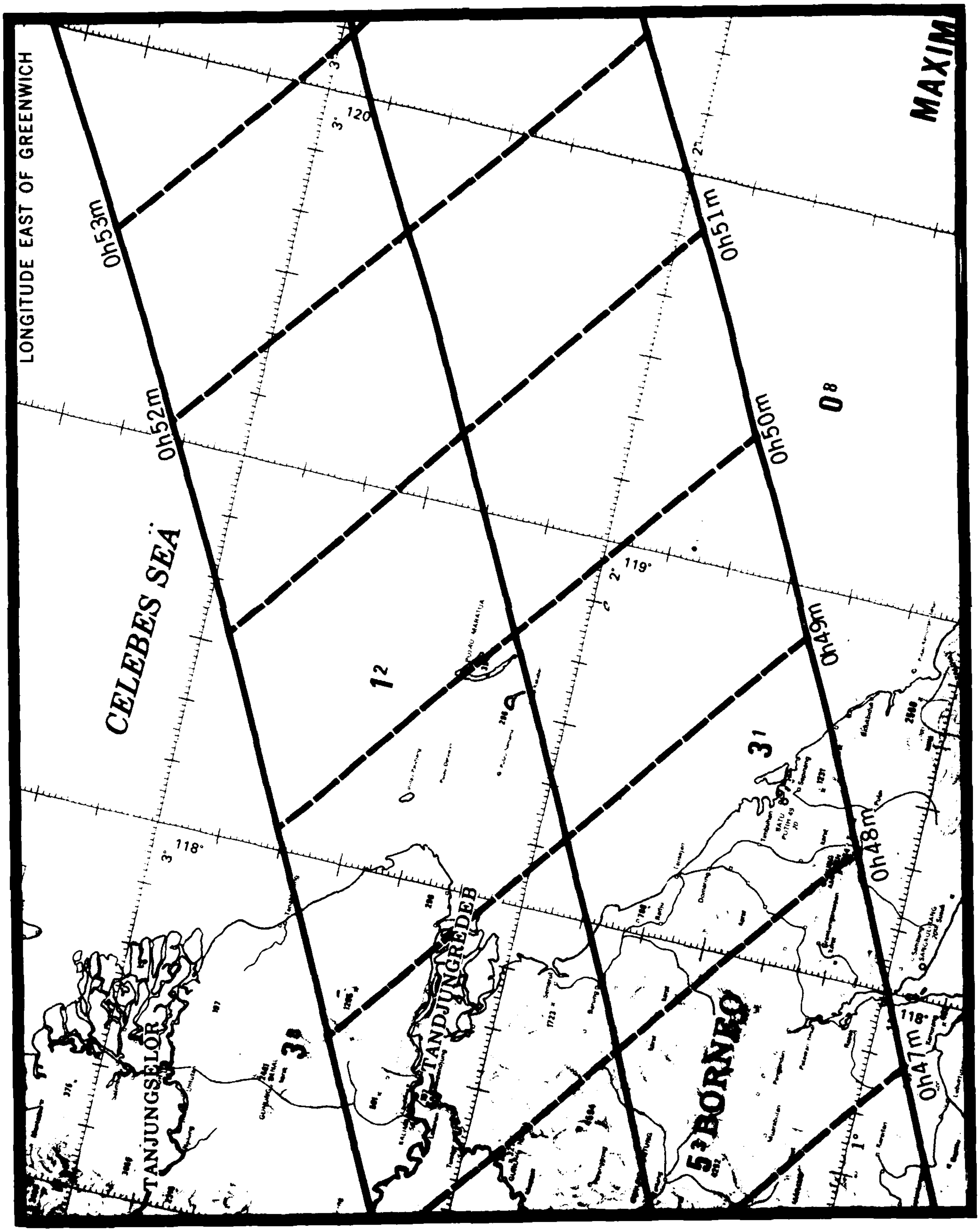

SUMATERA
(SUMATRA)
0h31m
0h30m
0h29m
PALEMBANG
PLADJU
SUNGAIGERONG
PERABUMULIH
MUARABELITI
TEBINGTINGGI
LAHAT
MUARAAMAN
BANGKAHULU
(mountain)
105°
104°
103°
LONGITUDE EAST OF GREENWICH

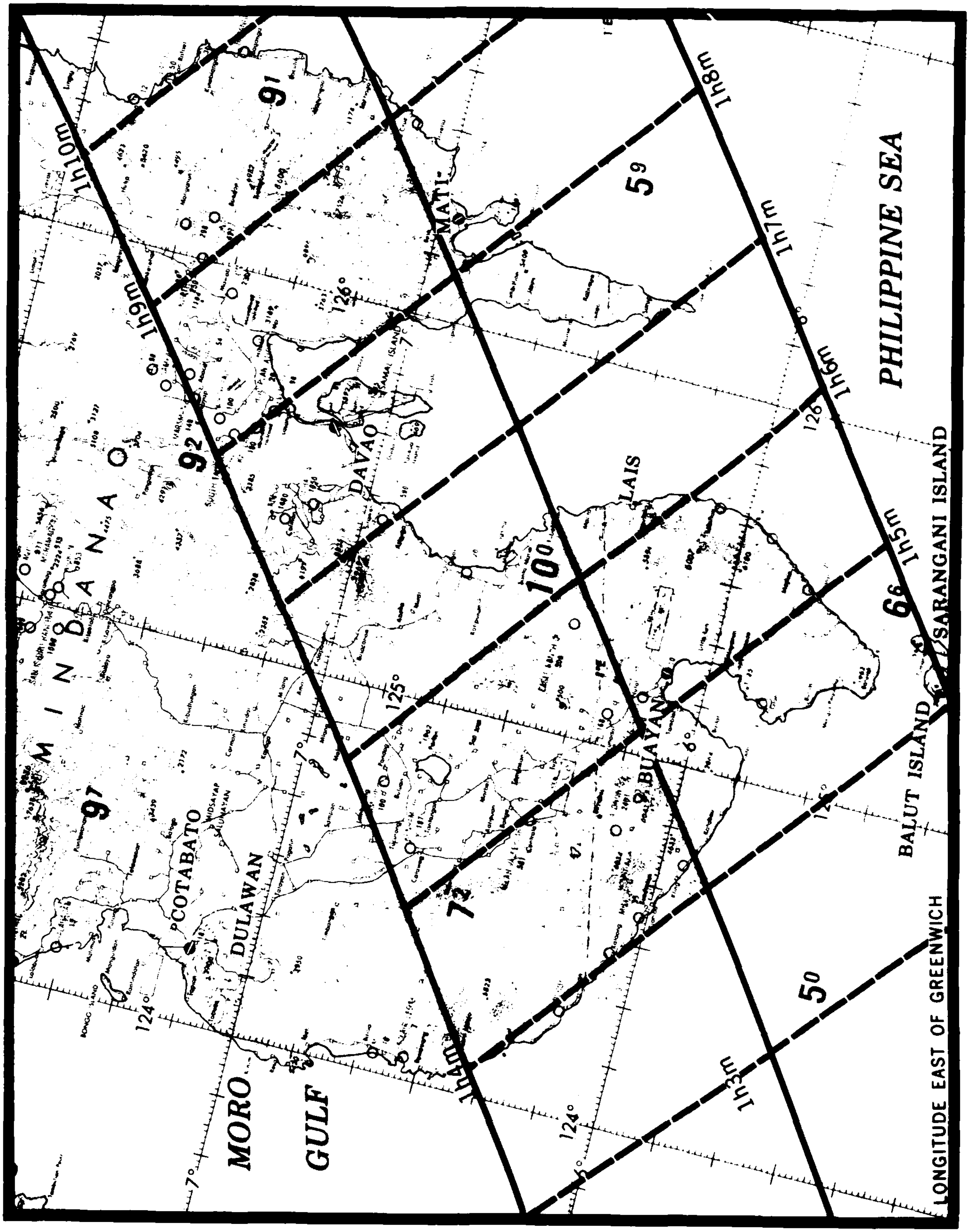

SOUTH CHINA SEA
0h34m
0h33m
0h32m
0h31m
108°
107°
PULAU BANGKA
BELINJU
SUNGAILAIT
PANGKALPINANG
MUNTOK
TOBOALI
PULAU LEPAR
TANDJUNGPANDAN
PULAU BELITUNG
RELIEF DATA INCOMPLETE
SUMATRA
LONGITUDE EAST OF GREENWICH


BORNEO
SOUTH CHINA SEA
SANDAE
KETAPANG
PULAU KARIMATA
KEPULAUAN (islands) KARIMATA
0h38m
0h37m
0h36m
0h35m
0h34m
111°
110°
109°
LONGITUDE EAST OF GREENWICH


0h42m
0h41m
0h40m
0h39m
0h38m
MEF BELIEVED NOT TO EXCEED
8100
MEF BELIEVED NOT TO EXCEED
8100
MEF BELIEVED NOT TO EXCEED
3300
MEF BELIEVED NOT TO EXCEED
1500
D NOT TO EXCEED
4500
RELIEF DATA INCOMPLETE
BORNEO
K A L I M A N T
NANGPINCH
SINTANG
LONGITUDE EAST OF GREENWICH
113°
114°
112°
1°
0°


0h48m
0h47m
0h46m
0h45m
0h44m
0h43m
0h42m
MAXIMUM ELEVATION FIGURES ARE BELIEVED NOT TO EXCEED 8100 FEET
BORNEO
RELIEF DATA INCOMPLETE
RELIEF DATA INCOMPLETE
RELIEF DATA INCOMPLETE
RELIEF DATA INCOMPLETE
117°
116°
115°
1°
0°
MEF BELIEVED NOT TO EXCEED
5200
LONGITUDE EAST OF GREENWICH


LONGITUDE EAST OF GREENWICH
MAXIM
0h53m
0h52m
0h51m
0h50m
0h49m
0h48m
0h47m
CELEBES SEA
TANJUNGSELOR
TANJUNGREDEB
BORNEO
120°
119°
118°



M I N D A N A O
PHILIPPINE SEA
MORO GULF
DAVAO
COTABATO
DULAWAN
BUAYAN
LAIS
MATI
SARANGANI ISLAND
BALUT ISLAND
LONGITUDE EAST OF GREENWICH
1h10m
1h9m
1h8m
1h7m
1h6m
1h5m
1h4m
1h3m
124°
125°
126°
7°
6°
5°

END
8-87
DTIC